PROCEEDINGS

International Online Symposium of Young Optometrists SIYO 2022

VNIVERSITAT DE VALÈNCIA

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INTERNATIONAL ONLINE SYMPOSIUM OF YOUNG OPTOMETRISTS

14-28 November 2022

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SIXTH INTERNATIONAL SYMPOSIUM OF YOUNG OPTOMETRISTS, SIYO 2022

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PREFACE

The Sixth International Symposium of Young Optometrists (SIYO 2022) took place from 14 to 28 November 2022 in its usual online format. This conference aims to create a space featuring young optometry students and optometry practitioners.

This book of proceedings contains the abstracts of the different contributions to the conference. Its contents are organized into two sections: invited and sponsored talks and workshops, and free communications. This last section is divided in talks and poster communications, comprising the conference's different thematic areas.

The Organizing Committee thanks all the young and senior researchers who have contributed their work to the conference, the members of the Scientific Committee for their careful review of the work and the different companies and academic or official entities that have sponsored this event.

The Organizing Committee

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GUEST LECTURES, SPONSORED TALKS AND WORKSHOPS

Assessing gaze via 3D motion-tracking: agreement with head-mounted eye-tracker

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Aim: We recently presented a method for measuring gaze location without the need for an eye-tracker [1]. The approach determines the assumed-gaze position by tracking the motion of the target that is being viewed relative to the orientation of the head. In the current study, we determine how closely changes in the assumed-gaze angle match changes in the gaze angle measured using an eye-tracker.

Experimental method: Participants wore a headband and a Tobii Pro "Glasses 3" eye-tracker, Fig. 1A. The head orientation was tracked (six-camera motion capture system, Vicon, 100Hz) using markers placed on the headband. To ensure that both gaze assessment approaches had comparable reference frames for gaze outputs, the head's reference frame was relocated to the eye-tracker's "Scene camera" position and rotated to match the participant's neutral gaze orientation. The gaze angles recorded by the eye-tracker during calibration were recorded as the offset angles.

Participants walked on a treadmill at Slow (80% Customary) and Fast (130% Customary) walking speeds. A smartphone (Fig. 1B), placed in front of participants at their preferred distance/orientation consecutively showed single random digits each lasting 750 ms (21 digits in total). The vertical size of these digits represented a visual acuity (VA) of 0.49 LogMAR at 0.4 m. Participants were asked to read the consecutively appearing digits aloud.

To determine how closely changes in the assumed gaze angle match changes in the gaze angle measured using an eye-tracker, we plotted the gaze displacement in the Up-Down (UD) and Right-Left (RL) assumed-gaze angles against those measured using the eye-tracker over the 15-second period (Fig. 1C). The Bland-Altman agreement [2] between techniques was applied in both spatial and temporal aspects, in addition to analysis of spatial congruence.

Results: Spatial agreement: the assumed-gaze approach showed good spatial agreement across speeds, with the angles assessed by the eye-tracker (mean

diff.; [±95%CI]): ΔUDGAZE: –1.08 [-5.09; 2.93] deg, ΔRLGAZE: –0.32 [–4.49; 3.85] deg. Temporal agreement: Changes in assumed-gaze had good temporal agreement with the changes in gaze determined by the eye-tracker (mean diff; [±95%CI]): Time lag: 22.86 [–84.84; 86.81] ms. Congruence: The directional changes in the assumed gaze trajectory were congruent with the direction of changes in the eye-tracker gaze trajectory, for ~80% of the analysed periods: (mean, ±SD): Slow (82.8% ± 8); Fast (79.6% ± 12.1).

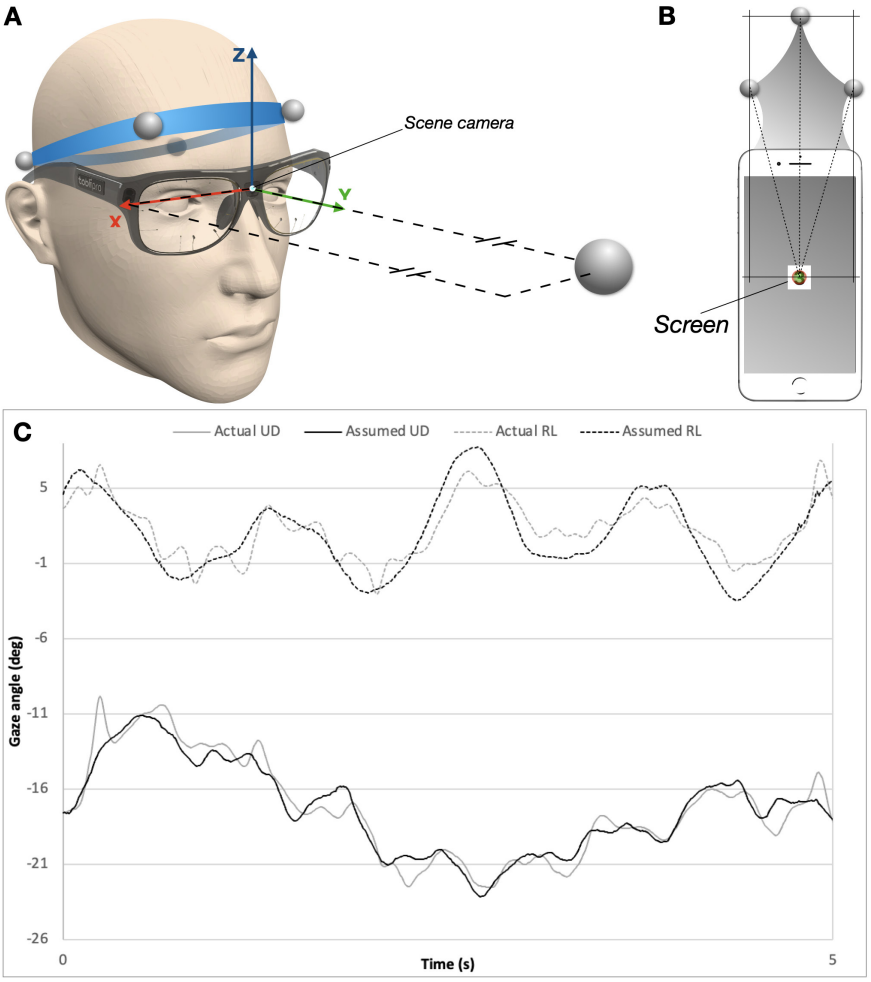

FIGURE 1. **A)** Subject calibration. Participants stood still and looked at a marker, horizontally and vertically aligned with the scene camera, placed 1.5 m in front of them. The origin (reference frame) for the assumed gaze was set at the position of the eye-tracker's origin (*scene camera*) and rotated to neutral. **B)** markers were used to track the phone screen. **C)** Pilot data comparing the assumed and actual gaze angles for the Up-Down (UD) and Right-Left (RL) directions. Only 5 seconds of data are shown.

Discussion: The agreement (spatial and temporal) was similar for Slow and Fast speeds, suggesting the assumed-gaze approach remains valid at faster head speeds and/or with increased head motion. Compensatory eye movements (i.e., saccades) and/or blinks, which were only recorded by the eye-tracker, may have affected the agreement determined. The assumed-gaze approach is a valid method for assessing gaze angles when it is known that the intended target is being viewed.

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Development of new objective techniques for ocular surface health assessment aiding early diagnosis of contact lens-related dry eye

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Aim: To find a new macro-type biomarker that could be objectively and non-invasively measured as an indicator of contact lens-related dry eye disease (CLDED), specifically in its early stage.

Experimental method: Fifty subjects aged (mean±standard deviation) 26±4 y/o were refitted with either silicone-hydrogel (Delefilcon A, SiHy, n=34) or hydrogel (Omafilcon A, Hy, n=16) daily disposable soft contact lenses. The study included seven visits: baseline measurements without contact lenses, two visits for contact lens fitting and selection, follow-up measurements after three, six, and

12 months of contact lens wear and a post-study visit without contact lenses. Lens-type selection was based on a set of objective measurements. Subjects were instructed to follow strict wearing rules. The study included measurements of tear film quality, tear quantity (meniscometry), ocular surface health markers, tear osmolarity and meibomian glands check-up and two new measurements of tear dynamic and tear clearance quantification (tear clearance and tear fluorescein wash-out).

Results: Changes in some of the ocular markers were evident throughout the duration of the study. Decrease in tear osmolarity over a period of one year was statistically significant for the whole duration of the study. Additionally, dynamic meniscometry responded to subtle changes in tear meniscus morphology. These changes were additionally expressed as changes in the optical coherence tomography-based tear clearance rate.

Discussion: This study shows that tear osmolarity [1], tear clearance [2] and dynamic meniscometry measures [3] could be used as potential biomarkers for supporting early CLDED diagnosis, whose markers are sensitive enough to follow the progression of subtle ocular changes in time and respond to effective therapy.

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The use of strategies to reduce myopia progression by Portuguese optometrists

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Aim: To study what Portuguese optometrists know about myopia progression control strategies and to discover which myopia progression control strategies are used in daily clinical practice.

Methods: During April and May 2022, a survey carried out on the Google Forms platform was distributed to the population of Portuguese optometrists. The survey asked if the professionals apply any strategy to control myopia progression and if so, what techniques did they use and what were the reasons that led them to choose a particular technique. Those who do not use any technique were asked why they do not use one and if they plan to do so.

Results: The validated sample contained 189 validated surveys, comprising 69.8% of people with degrees, 29.6% Master's degrees and 0.5% doctorates in Optometry. The age of the sample ranges from 22 to 59 years with a mean age (mean ± Standard deviation) of 38.0 ± 9.1 years. The professional experience of the participants ranged from 1 and 35 years with a mean value of 14.1 ± 7.4 years. 63.0% of the sample are female. Sixty-eight percent of the respondents use strategies to control myopia, with no statistically significant differences regarding the level of academic training, age or years of professional experience.

Regarding the myopia progression control strategies, 14.3% consider that undercorrection is a valid method, single-vision spectacles are considered valid by 22.8%, bifocal or progressive spectacles by 62.4%, low-addition spectacles by 65.1%, rigid gas permeable contact lenses (alignment fit) by 33.3%, soft single-vision contact lenses by 25.4% and vision therapy by 49.7%. On the other hand, 11.1% answered that orthokeratology has no effect or increases the progression of myopia, while 21.7% said the same about atropine, 24.3% said the same about combined treatments (e.g., atropine and orthokeratology) and 12.2% agreed regarding increased outdoor activity.

Regarding the methods used to control the progression of myopia, 11% only use a single strategy and the rest of the sample use several.

Of those who use methods to control myopia progression, 84.6% use specific myopia-controlling contact lenses, 66.2% use specific myopia-controlling spectacles, 10% use dual focus soft contact lenses, 9.2% use orthokeratology and only 0.8% use atropine and combined treatments. There is also a group of professionals who use techniques that are not validated or that have even been shown to be counterproductive for myopia progression control: 23.8% use low-addition spectacles, 19.2% use single-vision spectacles, 7.7% use undercorrection, vision therapy and single-vision soft contact lenses, 5.4% use progressive spectacles, 4.6% use bifocal spectacles, 3.1% use rigid gas permeable contacts (alignment fit) and 1.5% follow visual ergonomics recommendations. Finally, 62.3% recommend increasing outdoor activities.

Comparison with other studies conducted in different geographic areas:

To compare these results with the results related to other geographical areas, an analysis was made of the results obtained in other studies. The different sample size for each analysed study are:

- Wolffsohn et al (2020):
  - Global (Sample=1136)
  - Asia (Sample=202)
  - Australasia (Sample=79)
  - Europe (Sample=717)
  - North America (Sample=147)
  - South America (Sample=173)
- Martínez-Perez et al (2022): Spain (Sample=173)
- Douglass et al (2020): Australia (Sample=239)
- Jorge & Jesus (2022): Portugal (Sample=189)

Regarding optometrists' level of concern about the increasing prevalence of myopia, in Portugal, 29.5% of respondents rated their level of concern at 8, while 24.3% rated it as 9 and 31.2% rated it at 10. Calculating the mean ± standard deviation of the entire sample, the value obtained is 8.5±1. On average, optometrists' level of concern about this subject is similar in the various geographical areas:

- Wolffsohn et al (2020):
  - Asia (Mean ± Standard Deviation =9.0 ± 1.6)
  - Australasia (Mean ± Standard Deviation =7.6 ± 2.2)
  - Europe (Mean ± Standard Deviation =8.0 ± 2.2)
  - North America (Mean ± Standard Deviation =7.9 ± 2.1)
  - South America (Mean ± Standard Deviation =8.5 ± 2.2)
- Martínez-Perez et al (2022): Spain (Mean ± Standard Deviation =8.4±1.9)
- Jorge & Jesus (2022): Portugal (Mean ± Standard Deviation =8.4±1.9)

In Portugal, 14.3% of the respondents think that undercorrection can reduce myopia progression at rates of between 0% and 75%. In a study by Wolffsohn et al (2020), "the least effective perceived methods were single-vision distance under-correction and single-vision spectacles, as well as single-vision soft contact lenses and refractive surgery options". By continent, Australasian practitioners have the lowest perceived effectiveness of undercorrection on myopia progression control (mean ±SD =0.2% ± 6.6%) and South American practitioners have the highest (mean ±SD =14.9% ± 21.9%). In a study conducted by Martínez-Perez et al (2022), Spanish respondents said that undercorrection is 13.9% effective. In another study by Douglass et al (2020), Australian respondents did not refer undercorrection as an effective method to control myopia progression.

In Portugal, some respondents apply techniques to control myopia progression that are not supported by current scientific evidence, such as visual therapy (7.7%), undercorrection (7.7%) and low addition spectacles (23.8%). According to the study by Martínez-Perez et al (2022), in Spain, undercorrection is sometimes or always recommended by 30.8% of practitioners. According to Douglass et al (2020), in Australia, between 20% and 40% of practitioners recommend undercorrection with spectacles, between 60% and 80% recommend visual therapy and between 40% and 60% recommend "eye exercises" (e.g., massages and blinking).

Conclusions: The results of this study lead us to conclude that most Portuguese optometrists are aware of the myopia problem and interested in applying strategies to control myopia progression. This trend was also verified in the studies conducted by Wolffsohn et al (2020) and Martínez-Perez et al (2022). It seems that there is some illiteracy about the effects of strategies to control the progression of myopia in Portugal. It was also found that there are professionals applying techniques to control myopia progression that are not supported by current scientific evidence in Portugal, such as visual therapy, undercorrection and low addition spectacles. The results demonstrate the importance of strengthening the training of Portuguese optometrists in this area.

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Optical quality of aspheric intraocular lenses (IOLs)

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Aim: To evaluate and compare the effect of misalignment and tilt on the optical performance of different aspheric intraocular lens (IOL) designs with standard cornea and with simulated corneas after myopic and hyperopic laser ablation surgery.

Experimental method: To design the aspheric IOLs and to evaluate the effect of misalignment and tilt on their optical performance, a numerical model of a pseudophakic eye was implemented with a commercial optical design software program (OSLO EDU Edition 2001-2012, Revision 6.6.0 – Lambda Research Corporation) and ray-tracing simulations were performed. The model was based on the Navarro schematic eye [1]. The cornea of the eye model has a refractive power of 42.16 diopters (D) and a spherical aberration (SA) of +0.141 μm for a 6.00 mm entrance pupil diameter. IOLs models with refractive power +20.00 D were designed with a refractive index n = 1.485 at the design wavelength $\lambda 0$ = 546 nm. Lens A was an IOL with a negative SA to totally compensate the positive SA of the Navarro cornea. Lens B was designed as an IOL that does not add any SA to the eye. Lens C was designed with an amount of SA to partially correct the positive SA of Navarro's cornea. In this last case, the total ocular SA is slightly positive (+0.069 μm). See more details of the parameters of IOL lenses used in simulations in reference [2].

Moreover, two types of refractive surgery were simulated, a myopic and a hyperopic refractive surgery, to simulate the different amounts of spherical corneal aberrations induced by laser ablation. The conic constants used in the post-surgery eye models were obtained from the postoperative corneal asphericity (Q) values presented in the study by Bottos et al. [3]. Corneal asphericity values used to simulate corneas after myopic and hyperopiclaser ablation surgery

and SA calculated for a 6.00 mm entrance pupil were: Myopic (Q= +0.24 and SA= +0.734 μm) and Hyperopic (Q= –0.56 and SA= –0.086 μm). See more details on the procedure in the reference [4].

Once each IOL was designed, its optical performance was evaluated for each cornea (Navarro's eye model cornea and modified Navarro's eye model cornea) using OSLO optical design software for different alignment conditions. First, the IOLs were decentered horizontally from 0.00 mm (on axis) to 1.00 mm in 0.25 mm steps relative to the pupil center. Secondly, the optical IOLs axis was tilted relative to the corneal optical axis with the vertex in the pupil center (from 0.00 degree to 5.00 degrees in steps of 1.00 degree). For each misalignment and tilt, tangential and sagittal Modulation Transfer Function (MTF) at 100 cycles per degree for a 3.00 mm pupil diameter were calculated following the procedure described in ISO 11979-2 [5].

Results: Fig 1 shows on-axis MTFs and tangential and sagittal MTF results for misalignment (left column) and tilt (right column) for an IOL with a refractive power of +20.00 D. Regarding on-axis MTF, in Fig (left column) it can be seen that spherical IOLs clearly performed the worst, their MTF values being almost misalignment independent. Lens A on-axis MTFs are slightly higher than those of Lens B or Lens C. However, when the IOL was decentered, the amount of MTF degradation was strongly dependent on the IOL design. Lens A MTFs rapidly decay with misalignment and when decentered by 0.50 mm, its MTF value decays below 0.43. Lens B was scarcely sensitive to misalignment for all refractive powers, as even the MTF value increased with misalignment. Lens B MTF never decayed below 0.43 for any misalignment. Lens C offered better on-axis MTF values than Lens B, below 0.50 mm misalignment. However, when decentered by 0.75 mm, its MTF value fell below 0.43. Fig 1 (right column) shows MTF as a function of tilt. In this case, the MTF was less sensitive. The spherical IOL MTF was almost tilt independent. Fig 2 shows the average MTF values for Lenses A, B and C in the worst-case scenario (tilted 5.00 degrees and with a misalignment of 1.00 mm) with the three corneas, presenting a 3.00 mm pupil diameter. No average MTF above 0.43 is obtained with any considered cornea for any of the IOL designs. For all corneas, the average MTF values followed the same tendency. For the normal cornea (Fig 2A), the highest MTF value was obtained for Lens B, with 0.307 as the average MTF, followed by Lens C with an average MTF of 0.243. Lens A was the IOL with the lowest MTF with the normal cornea (0.182 as the average MTF). For the myopic and hyperopic corneas (Fig 2B and 2C), the highest MTF value was obtained for Lens B, while Lens A remained the IOL with the lowest MTF. With the myopic cornea, all lenses had their MTF values reduced. However, it is remarkable how Lens B MTF increased to a value of 0.386 with hyperopic corneas.

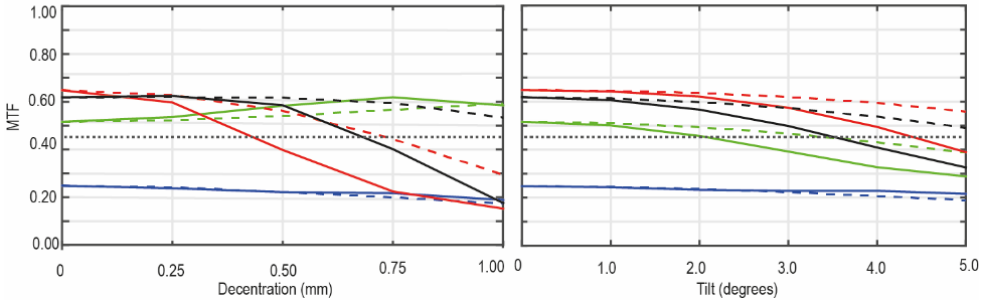

FIGURE 1. The MTF of the tested IOL as a function of decentration (left column) and tilt (right column) with a 3.00 mm pupil diameter and 100 cycles per degree. The tangential MTF (continuous line) and the sagittal MTF (dashed line) are shown. The horizontal dashed line represents the value of MTF 0.43 specified in the ISO 11979-2 [5].

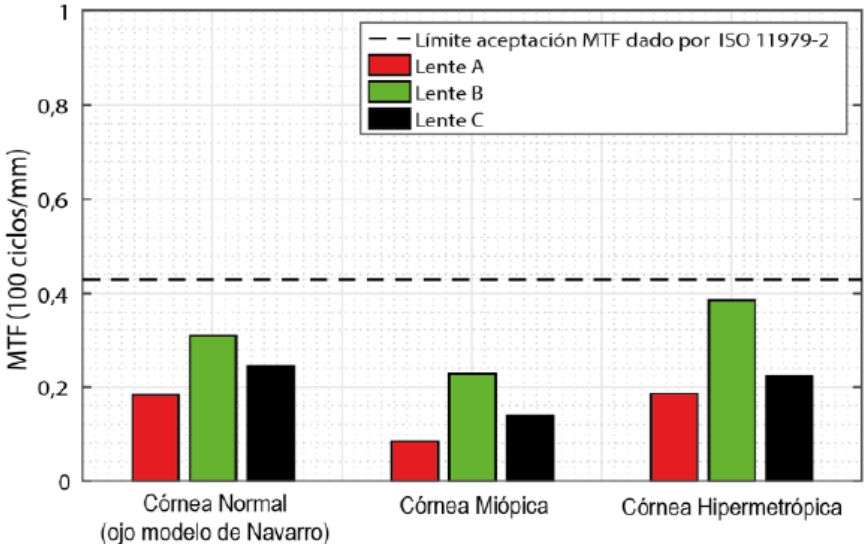

FIGURE 2. MTF average values (average between tangential and sagittal) for each IOL design (Lens A, Lens B and Lens C with each cornea, in the worst-case scenario: 5 degrees of tilt and 1 mm of misalignment. Corneas are represented in rows: **A)** Normal, **B)** Myopic, **C)** Hyperopic.

Discussion: Aspherical IOLs are more sensitive than spherical IOLs to misalignment or tilt, depending on their SA correction. The optical degradation caused by IOL misalignment had a greater effect on IOL designs with a higher amount of negative spherical aberration. In contrast, the effect of tilt on optical performance was less sensitive to the IOL design. Evaluated by means of the MTF, optical quality is dependent on the amount of SA correction of the IOLs for every studied cornea. The results obtained suggest that if the alignment cannot be guaranteed, aberration-free IOLs may be the best option

for a specific patient to provide acceptable imaging, even with some misalignment and tilt.

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Research collaboration

VICTORIA DE JUAN
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XAVIER PUIG
Alcon Healthcare, Barcelona, Spain

Aim: The aim of this guest talk is to show the different ways that Alcon and researchers in visual health collaborate.

Summary: Alcon's mission is to help people to improve their eye health. With that goal in mind, the Medical Affairs Department is the company's point of connection with researchers in visual health.

The Medical Advisor acts as a scientific advisor on Alcon products. His job is to help researchers to answer questions about purely scientific issues related to research projects. The Medical Advisor is also the point of contact between the researcher and Alcon to improve collaboration between both parties.

One of the problems that researchers often encounter is the lack of resources to carry out their ideas and publish the study they have designed in a scientific journal as the final result. The presentation will show how Alcon helps researchers to achieve their goals through participation in multi-center clinical trials, grant applications to carry out research-initiated studies or grants for publishing scientific results.

Collaboration between researchers and Alcon can undoubtedly be beneficial to both parties. They also share a very important common end goal: the development of better treatments, products and devices that help people to have better visual health.

New multi-diagnostic platforms and their application in optometric practice

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Product and Marketing Manager Visionix Iberia

Aim: This presentation explains the main features and clinical applications of the Visionix vx650 device.

Main content: VX650 is Visionix's innovative multi-diagnostic platform for the detection and complete monitoring of the main ocular pathologies. It combines topography, tonometry, pachymetry, aberrometry and retinography, as well as all the essential technologies to monitor anterior and posterior poles in a single device.

The optician-optometrist will be able to perform the following operations with this instrument in less than 90 seconds:

- Detection, evaluation and control of keratoconus
- Adaptation of special contact lenses
- Objective refraction according to day and night vision needs
- Cataract detection, assessment and monitoring
- Fundus analysis with non-mydriatic retinography
- Measurement of compensated intraocular pressure by means of pachymetry
- Evaluation of dry eye syndrome

The VX650 can be connected to Nexus, our Visionix digital health platform. Designed to connect all eye care professionals, even remotely, it brings eye care closer to patients, bridging barriers of time and space.

About Visionix: Based in France, Visionix is a leading company in the field of eye care. The company develops, manufactures and markets ophthalmic equipment ranging from refraction and multimodal diagnostics to finishing equipment. The Visionix brand comprises the former Luneau, Briot (edging), Weco (edging), Visionix (diagnostics and refraction), Next Sight (fundus camera and telemedicine solutions) and Optovue (high-speed OCT and OCTA technology) brands.

Figure device and main screen [1-2].

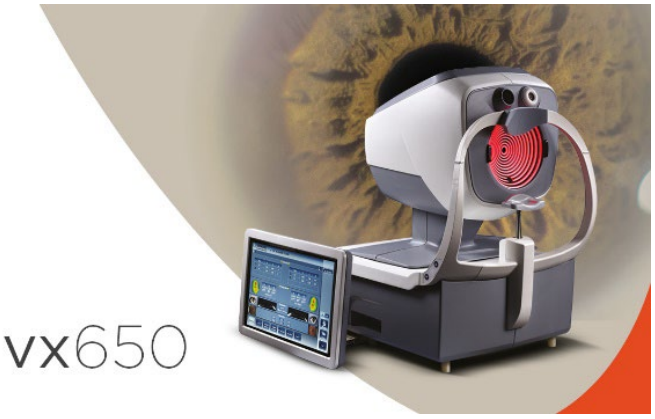

FIGURE 1. vx650 device.

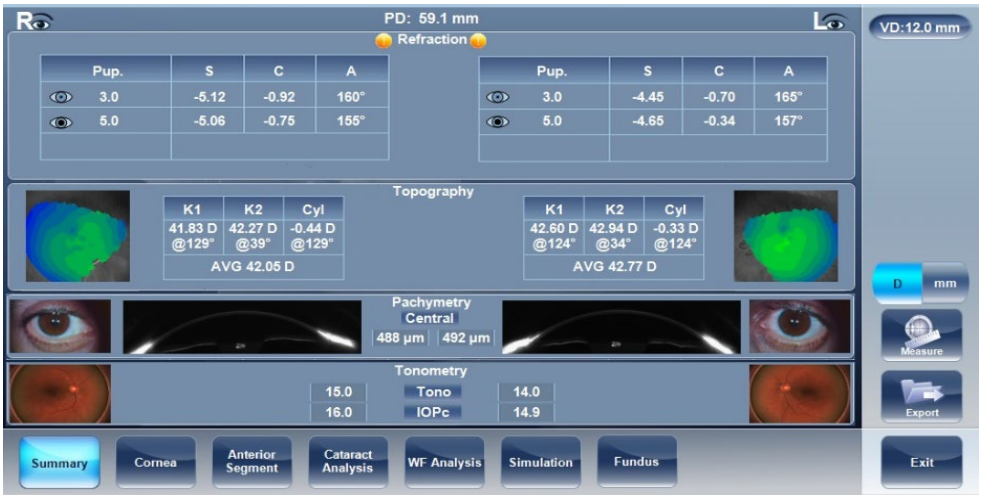

FIGURE 2. Main screen.

Discussion: This device provides several clinical applications that add value to optometry practices, in addition to saving time and space. It is also a very important tool for communication with the patient.

Indo Miopía

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Aim: Myopia is widely recognised as a significant public health problem, proven to be a major cause of vision loss, as well as a risk factor for various other serious eye conditions.[1] Myopia is one the most common refractive errors currently affecting 20% of children.[2] Myopia prevalence is increasing, with research suggesting that 52% of the global population will be myopic by 2050.[3]

Indo's goal is to provide a solution that allows the optician to offer the services and care needed during different stages of the Myopia process.

Experimental Method: Myopia is a refractive error which causes light rays entering the eye parallel to the optical axis to focus in front of the retina when ocular accommodation is relaxed, causing distant objects to appear blurred. Until now, the refractive error of myopia has usually been corrected with a standard single-vision minus lens. These lenses create a divergence of light, enabling the image to form on the central retina which, in turn, makes the image appear clearly.

However, when we correct myopia with a standard single-vision lens, light is brought to focus above the central retina, yet the clear image is peripherally projected behind the retina, thus generating peripheral hyperopic defocus. The peripheral defocus created by the lens induces axial elongation in an attempt to focus the image, thus having a counterproductive effect on myopia progression.

The various scientific studies have shown that the population most at risk of myopia progression shows an asymmetry between the nasal and temporal regions of the retina.

Results: In relation to retinal profiles, the results show a significant difference in nasal retinal steepness for progressing myopes. The conclusion is that greater nasal retinal steepness is linked to a progressive increase of myopia.

The Superkid Miofocal lens is a peripheral defocus lens with a horizontally asymmetrical design. It has a central vision zone, which provides stable refraction around the optical centre, while an outer zone creates peripheral progression along the horizontal meridian (Figure 1).

The Superkid Miofocal lens has been clinically tested in a trial conducted over 5 years with Caucasian children. These long-term studies have shown that the Superkid Miofocal lens reduces the progression of myopia by 40%.

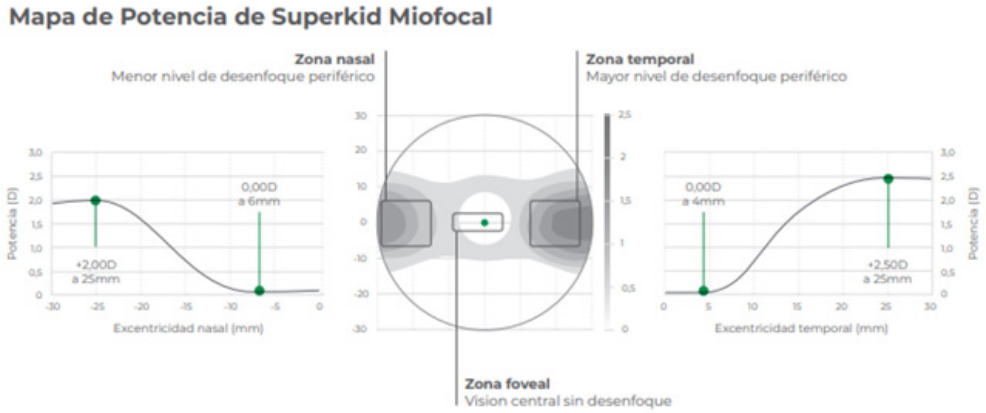

FIGURE 1. Superkid monofocal design.

Discussion: This optical design allows light to adapt perfectly to the retina's characteristics. As shown in Figure 1, light entering the optical centre of the lens is focused correctly on the retina, as occurs with a standard lens. However, light entering through the nasal zone of the lens focuses on the temporal hemifield, while light coming through the temporal zone, which is more powerful, focuses on the nasal zone, in line with the asymmetrical needs of the myopic eye.

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Ocular surface evaluations for the detection of dry eye

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Dry eye is a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage and neurosensory abnormalities play etiological roles. Considering its great prevalence in the adult population, it is of great interest that optometrists known how to perform an ocular surface evaluation to detect abnormalities of the ocular surface that could be treated by specialists. Consequently, this workshop aims to detail the procedure of an ocular surface test designed to evaluate dry eye in clinical practice. Particularly, it will address an assessment of the corneal and conjunctiva staining, tear break-up time, tear production by Schirmer test, tear osmolarity using the Tearlab device and an assessment of dry eye symptoms with the Ocular Surface Disease Index (OSDI) questionnaire.

1
TALKS

1.1. ANTERIOR SEGMENT

Anterior ocular segment analysis and correlation between biometric parameters involved in refractive surgery

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Aim: To establish correlations between biometric parameters that integrate the anterior ocular segment and are involved in processes such as refractive or cataract surgery, as considering the morphologic condition of the parameters helps clinics to establish inclusion criteria and guarantee safe surgery for patients.

Experimental method: Exclusion criteria included previous ocular surgery, having used contact lenses within less than 24 hours and being a minor or above 40 years old. Accepted patients were required to sign an informed consent form. Three measurements were taken for each patient using VISIONIX VX-130 (Visionix, Pont-de-l'Arche, France), including: autorefractometry (wave front analysis), corneal topography, anterior segment biometry by Scheimpflug sweep and non-invasive intraocular pression measurement.

Results: This study included 55 eyes (55 patients). Firstly, correlations between anterior segment parameters without any group differentiation were analyzed, resulting in a high negative correlation between spherical equivalent and anterior chamber depth (ACD) ($p=0.003$) and white-to-white (WTW) ($p=0.010$); while there were positive correlations with angle kappa ($p=0.025$) and eccentricity ($p=0.012$), as well as elevated positive correlations between keratometry and iridocorneal angles ($p=0.034$) and negative ones with WTW ($p<0.001$). There were also positive correlations between central corneal thickness (CCT) and intraocular pressure (PIO) ($p=0.021$). There were negative correlations between ACD

and angle kappa (p=<0.001), as well as with eccentricity (p=0.008) where found, in addition to positive ones with temporal/nasal iridocorneal angles (p=<0.001) and WTW (p=<0.001). Angle kappa is negatively correlated with temporal/nasal displacement (p=<0.001) and temporal/nasal iridocorneal angles (p=<0.001). Likewise, a positive correlation between both nasal/temporal iridocorneal angles was found (p=<0.001) and a negative one was detected with eccentricity (p=0.009). Afterwards, data was divided in accordance with spherical equivalents, resulting in four groups: hyperopia (1), low myopia (2), moderate myopia (3) and high myopia (4). There were significant statistical differences between groups regarding ACD (p=0.010) and WTW (p=0.013). Finally, it was demonstrated that the biggest differences between the parameters and the spherical equivalent were found within the hyperopia (1) and high myopia group (4), suggesting that whenever the value of the spherical equivalent is more negative (myopic tendency), the anterior ocular segment structures will be larger in size.

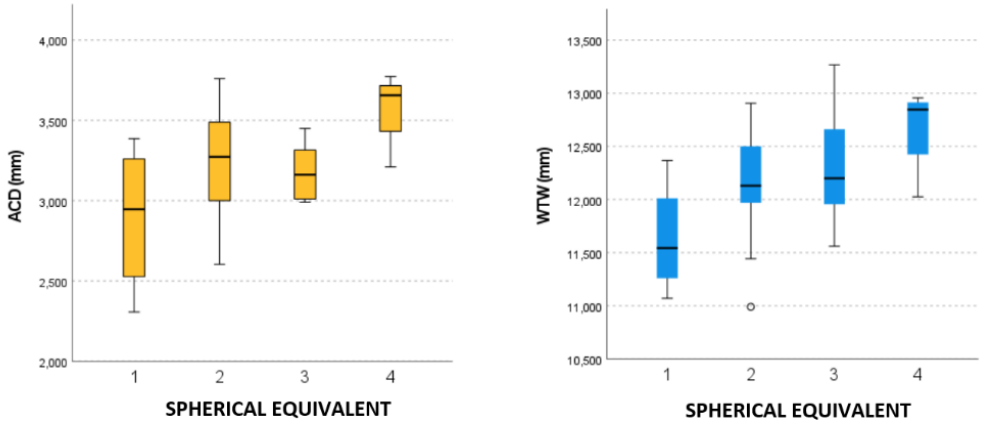

FIGURE 1. Box and whisker plot between spherical equivalent and ACD/WTW.

Discussion: Anterior ocular segment parameters are significantly correlated between them, as well as with the spherical equivalent. There are morphologically related structures with outcomes like a strong positive correlation between ACD and both nasal/temporal iridocorneal angles. There was also a demonstrated tendency for the size of the anterior ocular segment parameters to be larger as the spherical equivalent was more negative, as can be seen in Figure 1, where the ACD and WTW were bigger in eyes with a more myopic refractive value.

Beyond these outcomes, there is a parameter that should be highlighted due to its importance when performing ocular surgery, especially refractive surgery with laser ablation, where the surgeon must adjust the centration of the laser in relation to this parameter: angle kappa. It was found to be positively correlated with spherical equivalent, ACD, displacement and iridocorneal angles, suggest-

ing a tendency for hyperopic eyes to have larger angles kappa, a characteristic that complicates the procedure. Moreover, angle kappa used to be displaced temporally when its value was higher.

The discoveries of this study are related to other researchers' results. However, complementary studies using diverse clinical devices should be conducted to establish agreement relations and repeatability between instruments.

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Considerations when defining keratoconus progression: the role of previous knowledge

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Aim: Corneal crosslinking (CXL) is major breakthrough in keratoconus (KC) management. However, there has also been a debate about its efficiency. Cochrane reviews have deemed its evidence limited, and there is no consensus on which KC need CXL, nor on how to establish progression [1-2]. This is complicated further by increased noise in KC measurements. This study aimed to verify the performance of diverse progression criteria, as well as to what extent the results match previous clinical knowledge on keratoconus evolution.

Experimental method: Retrospective longitudinal study with 743 KC patients measured with Pentacam. Habitual progression criteria were analyzed based on (combinations of) maximum keratometry (KMAX), anterior corneal astigmatism (AF) and minimum pachymetry (PMIN) or were based on the ABCD Progression Display. For each progression criterion and cut-off, we calculated the eyes

flagged as progressive at some point (RPROG), the individual longitudinal consistency CIND (i.e., the percentage of examinations after the first detection of progression that would be still considered progressive) and the population consistency CPOP (the percentage of eyes with CIND > 66%). Finally, we studied more monotonic and consistent variables [3] such as front steep keratometry (K2F), keratometry in a 3 mm area around KMAX (KZONAL3mm) and the average radius of the back surface (RmB).

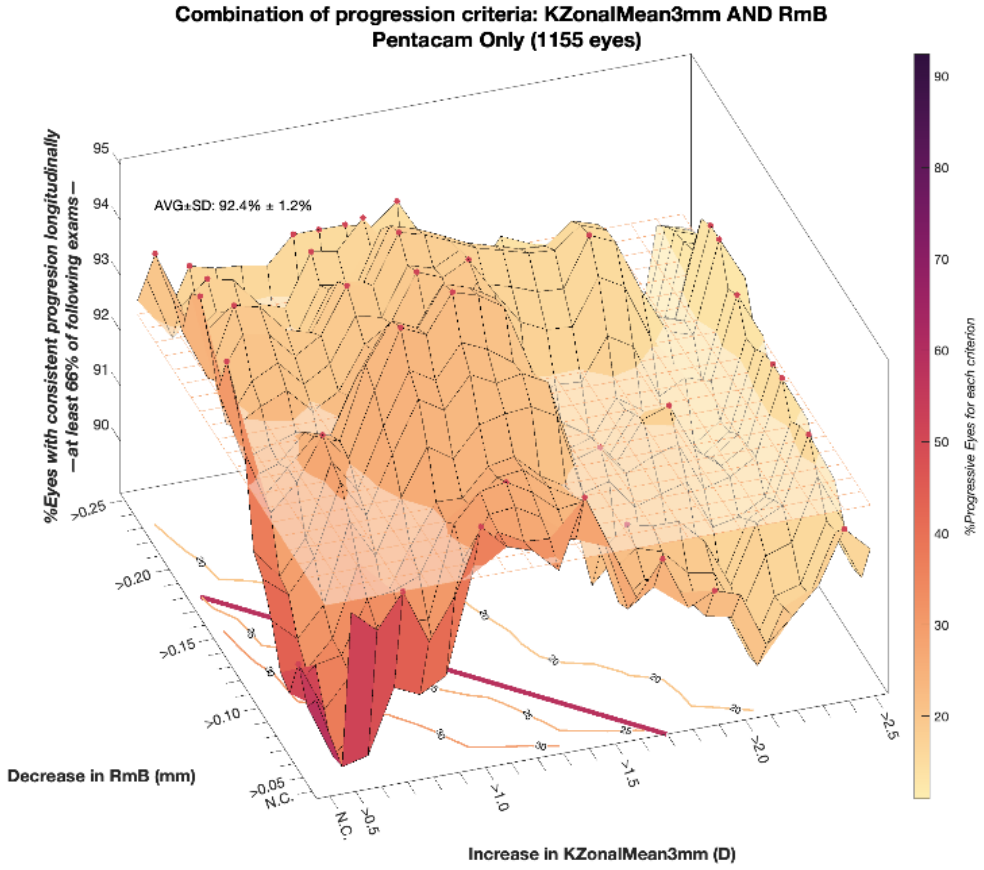

FIGURE 1. Progression surface. Color represents the rate of progressive eyes (R_{PROG}) and the surface represents the longitudinal population consistency (C_{POP}).

Results: Using a single criterion (e.g., ΔKMAX >1D) led to rather high values of RPROG, unless the cut-off was well over repeatability. When two criteria were required, (KMAX AND AF), this led to worse CPOP and higher variability than (KMAX AND PMIN); alternative criteria (KZONAL3mm AND RmB and K2F AND RmB) obtained the best CPOP and the lowest variability (Figure 1,

$p < 0.0001$). ABCD, as defined by its authors, obtained a very high RPROG of 74.2%. Using wider 95% confidence intervals (95CI) and requiring two of ABC over the 95CI reduced RPROG to a more realistic 27.9%.

Discussion: Clinical observation of visual acuity loss, contact lens parameters changing [4-5] the incidence of scarring and corneal transplants suggest that 20-35% of KC are progressive. These clinical RPROG observations should be considered when defining KC progression to avoid overtreatment. By using combinations of alternative variables and wider 95CI for ABC, the RPROG can be brought closer to clinical observation. Ffurthermore, these approaches obtained better longitudinal consistency than current definitions.

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Development of a new experimental formula for the approximation of total corneal power in post-LASIK patients

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Aim: The curvature of the posterior corneal surface was unknown until the development of anterior segment optical coherence tomographs. Because of this, keratometers and videokeratometers identified a physiological relationship between the anterior and posterior corneal surface of 1.23 (a/p ratio = 88%) to calculate total corneal power (TCP). This ratio resulted in what is called the keratometric refractive index (1.3375). However, in patients undergoing corneal refractive surgery, an error is made in keratometric measurements due to this mistaken assumption of ratios. Several authors have published formulas to try to predict TCP in post-LASIK patients [1-3]. The aim of this study is to develop a novel empirical formula for the prediction of TCP in post-LASIK patients, with only data from the anterior corneal surface.

Experimental method: Data from 100 post-LASIK eyes belonging to 64 patients were reported for the development of the empirical formula. Through the SimK formula used by keratometers to calculate corneal refractive power (formula 1), we obtain the expression allowing us to calculate the post-LASIK refractive index (n') for each case (formula 2). The True Net Power (TNP) and the anterior corneal radius were measured one month after surgery using Pentacam® tomograph (OCULUS, Wetzlar, Germany).

$$\delta = \frac{(n-1)}{r} \qquad n' = (\delta'.r') + 1$$

(formula 1) (formula 2)

(n'= post-LASIK refractive index; δ'= true net power (pentacam); r'= post-LASIK anterior corneal surface radio).

Due to high correlation between the preoperative spherical equivalent and n' variables, a linear regression analysis was performed to predict n' based on preoperative data (figure 1).

In this way, knowing the predictor formula of the post-LASIK refraction index (n'), we can make an approximation of the total power in post-LASIK patients with only data from the anterior cornea surface using the following expression:

$$\delta = \frac{(0.3363 - 0.0023EE)}{r}$$

(δ= Post-LASIK total corneal power; EE= Preoperative spherical equivalent; r: post-LASIK anterior corneal radius).

To validate this empirical formula, it was compared with Maloney's method [1], which has been widely accepted by clinicians and the scientific community.

Results: To compare both formulas, we made Bland-Altman graphs for each. This analysis gives us the information of the prediction error using pentacam TNP as the standard reference. The average prediction error for our new model was 0.02±0.36 D (95% CI: –0.68 and 0.72 D) versus 0.36±0.46 D (95% CI:-0.54 and 1.25 D) generated using Maloney's method [1]. The average TCP was 39.94±2.11 D, 39.60±2.03 D and 39.96±2.15 D for the new experimental formula, Maloney's method and Pentacam TNP, respectively, p<0.01 (ANOVA).

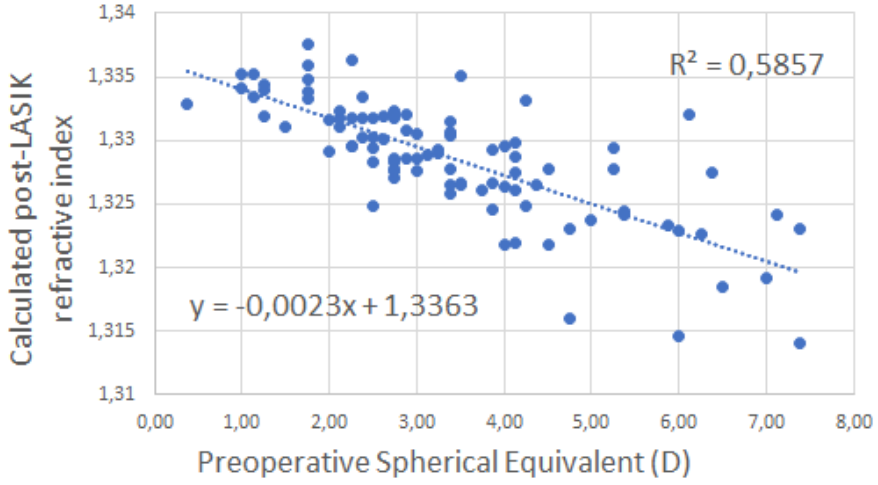

FIGURE 1. Linear regression. Refractive index post-LASIK (y-axis) versus preoperative spherical equivalent (x-axis) (diopters).

Discussion: Other published research has shown an expression similar to ours for the approximation to the postoperative refractive index [4]. However, no final prediction method for postoperative keratometry has been developed. The empirical formula developed by the authors can be used for the approximation of

total keratometry in post-LASIK patients only by knowing parameters of the anterior corneal surface.

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Sectorial corneal asphericity in keratoconus: before and after intrastromal corneal segment ring implantation

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Aim: The main objective of this study is to evaluate sectoral corneal asphericity in keratoconus eyes before and after the implantation of intrastromal segments.

Method: A retrospective observational study was conducted in which 50 keratoconus eyes were involved. The inclusion criteria were grade I to III keratoconus

according to pentacam topographic keratoconus classification (TKC scale), Kmax <60 D and preoperative corrected distance visual acuity > 0.15 logMAR. Different corneal parameters were evaluated using pentacam AXL Pentacam® (OCULUS, Wetzlar, Germany) before surgery and three months after surgery. The sectorial corneal asphericity measured in the 4 quadrants around 6 mm, the total average asphericity, the simK and the vertical coma were all evaluated. P-values lower than 0.05 were considered statistically significant.

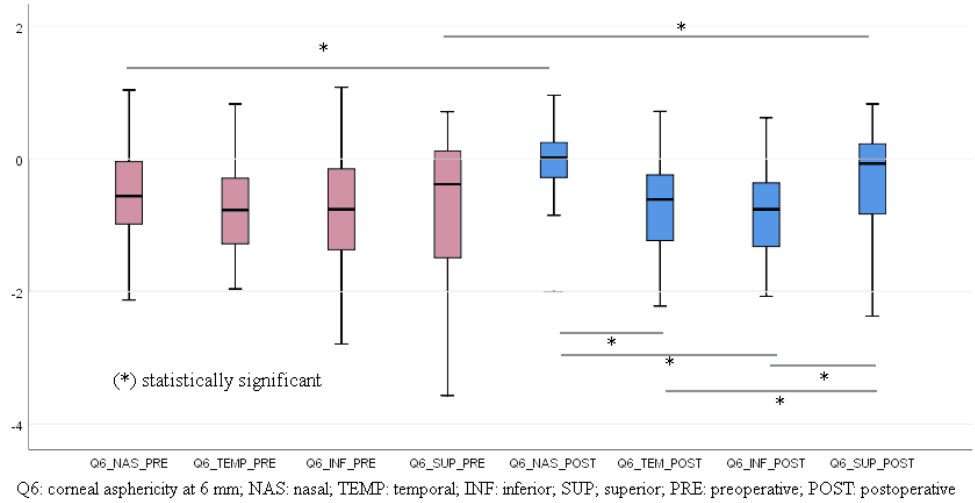

FIGURE 1. Box and whisker diagram: Sectorial corneal asphericity.

Results: No statistically significant differences were found in preoperative sectorial asphericity between the four hemimeridians: –0.64 ± 0.87 nasal hemimeridian, –0.84 ± 0.71 temporal, –0.72 ± 0.85 inferior and –0.69 ± 1.06 superior (p = 0.09). After surgery, these parameters were –0.11 ± 0.76, –0.73 ± 0.73, –0.79 ± 0.82 and –0.37 ± 0.91, respectively (p <0.001). The post-oc Bonferroni test showed differences between the inferior-temporal hemimeridians and the superior-nasal hemimeridians. At the same time, there was only a change in asphericity between the pre and post values for the upper (p= 0.006) and nasal hemimeridians (p <0.001). Vertical coma aberration decreased from –2.53 ± 0.97 preoperative to –1.53 ± 0.81 postoperative (p<0.001). The mean keratometry was flattened from 48.64 ± 8.05 to 45.75 ± 2.51, respectively (p=0.01).

Discussion: Corneal hyperprolaticity in patients with KC decreased significantly after corneal segment implantation [1]. However, during the present study it was observed that these changes in mean corneal asphericity occurred only in the nasal and upper meridians, while no significant differences were found in the in-

ferior-temporal sectors. According to the results obtained in the present study, we obtained that segment implantation tends to regularize the anterior corneal surface, producing a central flattening and a peripheral steepening in the upper-nasal area.

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1.2. CONTACT LENSES

Decrease of myopic progression rate by orthokeratology: three-year results of a retrospective study

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Aim: To study the effectiveness of overnight orthokeratology in a group of young myopic subjects over a three-year period. This retrospective study compared data from clinical records of 41 myopic children fitted with overnight orthokeratology (OK group) and 41 myopic subjects treated with single-vision glasses (control, C group).

Experimental method: The clinical records were acquired in two different private optometric clinics, one for the OK group and the second for the C group. The inclusion criteria for treated subjects were those indicated by IMI [1]. The subjective refraction was carried out without cycloplegia by two different optometrists, one for the OK group and the other for the C group. The C group was matched according to ethnicity, age and refractive error with the OK group.

Results: The mean spherical baseline equivalent was –2.85 ± 1.55 and –2.51 ± 1.61, for the OK and C group, respectively. The follow-up data was available for two years for all 41 subjects of each group and for three years for 30 subjects in the experimental group vs 25 in the C group. The data of the three years follow-up were analyzed. The increase in myopia at 3 years was –0.48 ± 0.43 D for the OK group and –1.52 D ± 0.90 D ($p < 0.01$) for the C group. The comparison

between the two groups is summarized in Figure 1. The Wilcoxon rank-sum test was used because of the non-normal distribution of some of the variables. The differences found in the myopia progression rates between the two groups (OK vs C) for each year were: –0.15 vs –0.47 ($p<0.01$) in the first year, –0.13 vs –0.47 ($p<0.01$) in the second year and –0.19 vs –0.39 ($p<0.01$) in third year). Children treated with OK lenses reported 68% less myopic progression compared to children corrected with single vision ophthalmic lenses after three years. There were no serious complications or adverse events in the three years of the study.

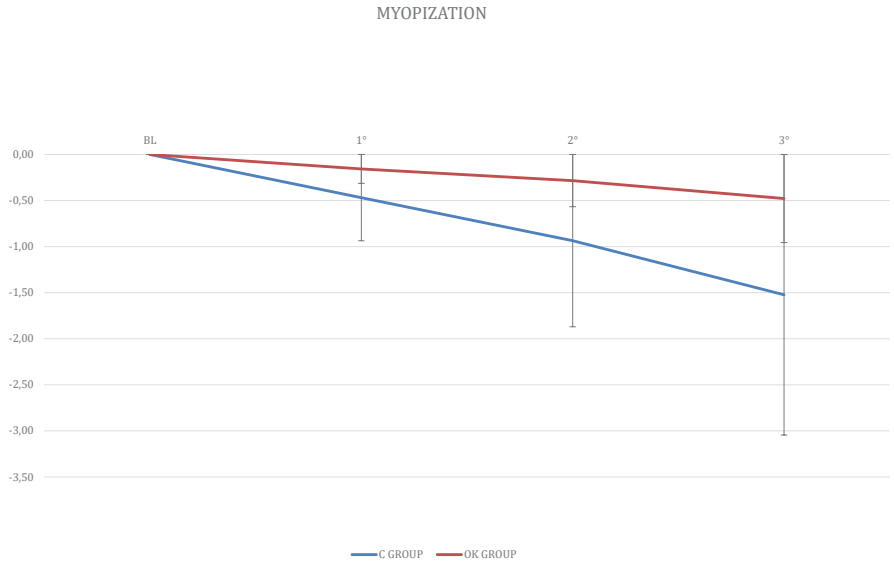

FIGURE 1. Myopization progress during the three-year follow-up.

Conclusion: The results of this retrospective study confirm that overnight OK is a reliable way to slow down myopic progression, compared to single-vision glasses. The rate of the reduction of the myopic progression for the OK group is in line with others published in the literature [2-6]. No adverse events caused subjects to stop wearing the lenses or drop out. Overnight orthokeratology can be proposed as a myopia correction technique and its spread among practitioners could help to contain the increasing prevalence of this refractive error.

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Evaluation of changes induced in the tear film due to computer use, contact lens wear and artificial tears using novel methods

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Aim: There is a need to develop new metrics to assess the tear film and the ocular surface objectively and non-invasively [1]. This study aims to evaluate the effects of computer use, contact lens wear and artificial tears on recently developed metrics to assess tear film dynamics and the lipid layer [2, 3].

Experimental method: Forty healthy subjects (Mean ± Standard Deviation: 23.2 ± 2.6 years) were enrolled in this study, which focused on 40 eyes. The tear film was assessed under different conditions. Baseline measurements were taken in the first visit and participants performed a reading task on a laptop computer for 20 minutes. After the 20-minute reading task, measurements were repeated. After the visit, contact lenses (Dailies Total One®, Alcon Laboratories Inc. Fort Worth TX, USA) were fitted and the subjects were instruct-

ed to put in the contact lenses 1 hour before the second visit. In the second visit, measurements were repeated (with the contact lenses) and participants were instructed to read on the computer for 20 minutes while wearing the contact lenses. One drop of Systane® Ultra (Alcon SL, Geneva, Switzerland) single-dose artificial tears were instilled on each eye 2 minutes before doing the reading. After the reading task, the tear film was assessed again. New metrics included the assessment of tear film dynamics through the measurement of the speed of tear film particles post-blink and the objective evaluation of lipid layer thickness by measuring the intensity of the reflected Placido disk onto the tear film (Figure 1). Higher particle speed is related to higher stability of the tear film and higher intensity of the reflected Placido disk is related to a thicker tear film lipid layer [2, 3].

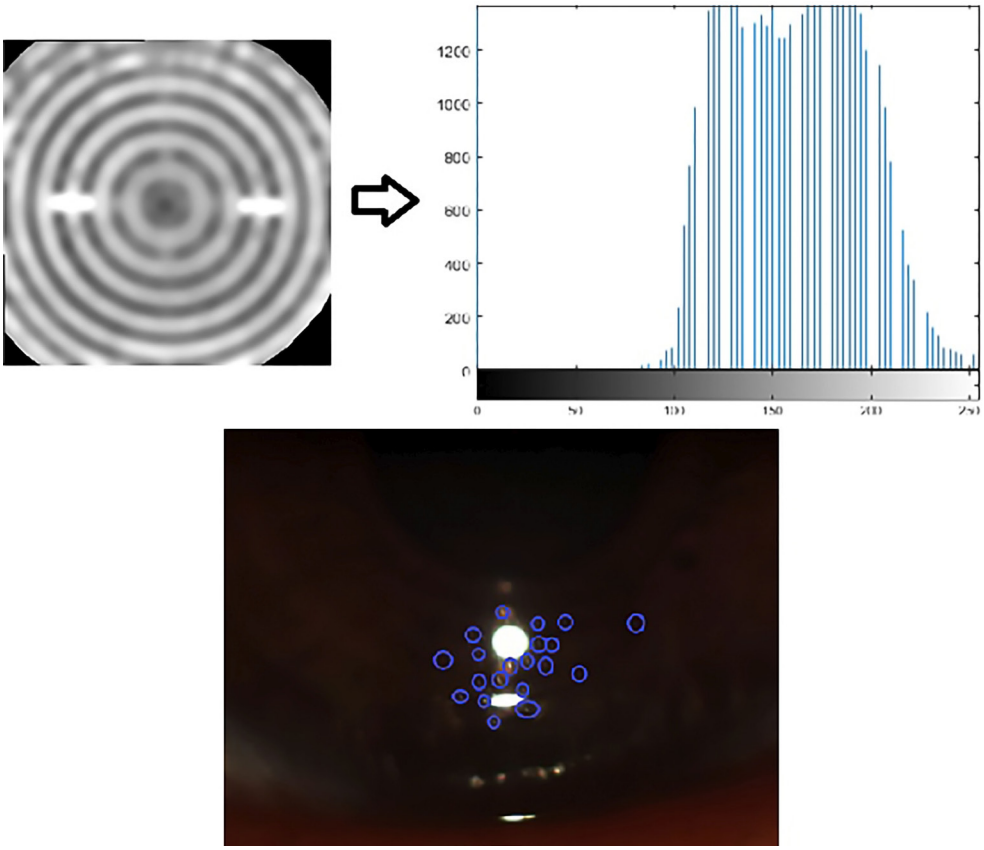

FIGURE 1. Top: Histogram of Placido disk pixel intensity distribution in one frame. In the histogram, the "x" axis represents the grey level intensities (0-255), while the "y" axis shows the number of pixels. Bottom: Particles spread after blinking in one frame. Light particles spread over the cornea (blue circles).

Results: After computer use, lower values were obtained in metrics related to the intensity of the Placido disk pattern ($p<0.001$) and in metrics related to particle speed ($p<0.030$). Moreover, when the contact lens was fitted, lower values were found for particle speed ($p<0.019$), but no differences were found in the intensity of the Placido disk ($p>0.05$). Mixed ANOVA showed that artificial tears help ameliorate the effects of computer use on metrics related to particle speed post-blink and the intensity of the Placido disk ($p<0.028$).

Discussion: Computer use and contact lens wear worsened lipid layer thickness and tear film dynamics. Remarkably, the speed of particles can be influenced by the surface on which they move, causing an alteration in tear film dynamics. Moreover, artificial tears help to ameliorate the deterioration of these parameters after reading on a computer. This study further helps to validate these novel methods as a reliable tool to quickly, non-invasively and objectively assess changes in the tear film induced by different conditions.

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Tear film dynamics with eyelid and contact lens motion for full blinks and half blinks

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Aim: The tear film is important in eye optics due to its influence on dry eye, contact lens fit, etc. A mathematical model is used to assess the blinking of eyelids by coupling partial differential equations for tear film thickness to contact lens motion. This article aims to study tear film dynamics when using an experimental real motion of the eyelid and the influence of contact lens motion on the eye in real patient situations.

Experimental method: The dynamics of the tear were simulated with a precorneal tear film model with blinking and contact lens motion. The model uses the standard parameters given in [1], changing the values of the meniscus (experimental values) and the thickness of the contact lens. The eye meniscus height can be measured with Optical Coherence Tomography (OCT) for different patients. The motion of the upper lid during blinking was defined as a sinusoidal function as given in [2], where a fraction parameter is used to represent the difference between half blinks and full blinks. The model was developed with MATLAB software and toolboxes [3].

Results: The principal result given by the model is the thickness between the tear film and the contact lens surface (pre-lens with lens) and the total thickness of the tear film without the contact lens (pre-corneal). The difference between the pre-corneal (PCTF) and pre-lens tear film (PLTF) characterizes the dragging of the tear fluid. Figure 1 shows the simulation of the mathematical model of tear film thickness for an eye fully open after the blink (160 ms) for a sinusoidal eyelid and contact lens motion for full blinks (Figure 1 center) and half blinks (Figure 1 down). The thickness of the pre-lens tear film is higher than the pre-corneal tear film in full blinks, except very close to the lower lid. For a half blink, we see that tear film thickness for a pre-lens tear film is lower at the lower lid.

Discussion: The main difference between pre-corneal tear film and pre-lens tear film is how the contact lens moves the tear fluid in the direction of motion

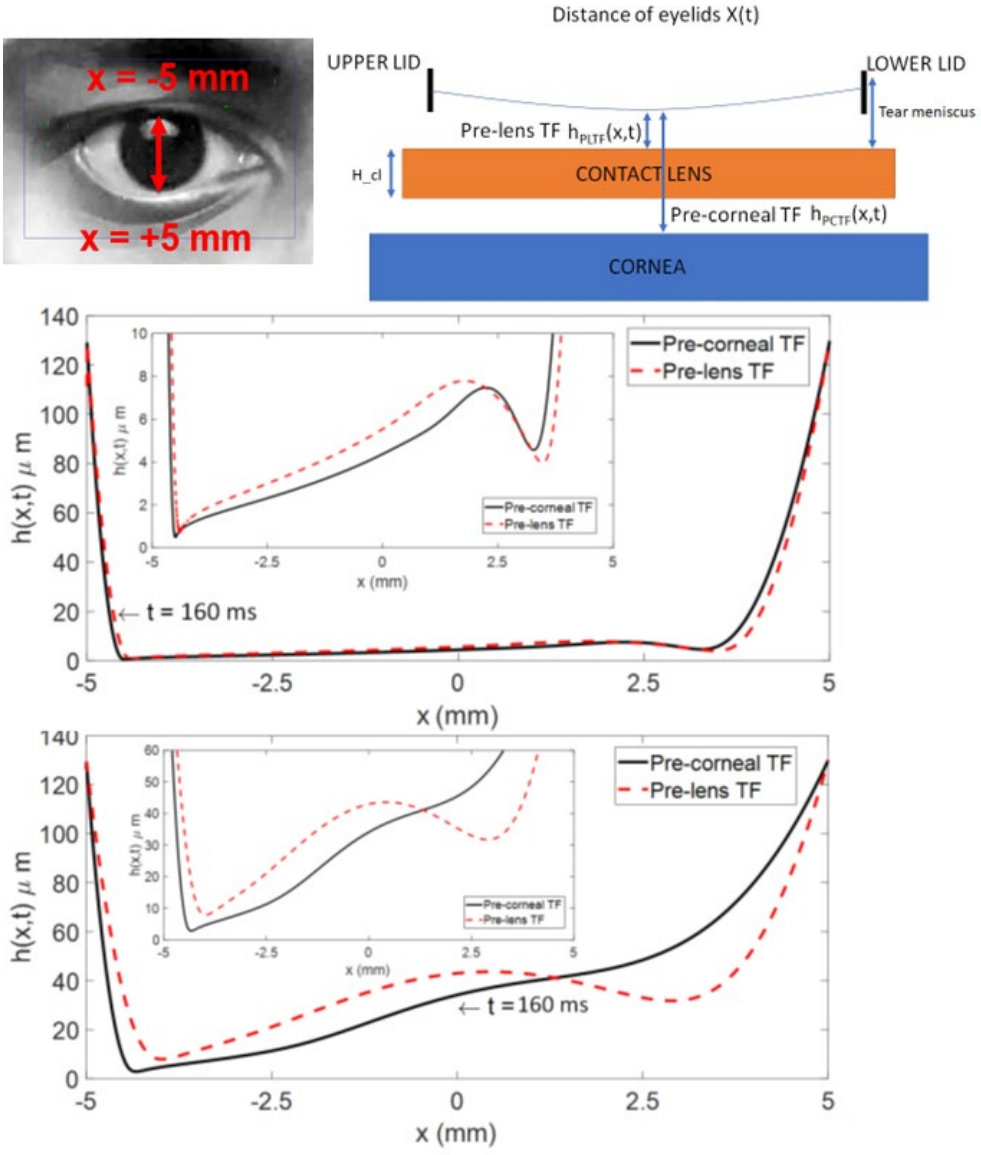

FIGURE 1. Up: Schematic diagram of the precorneal tear film, pre-lens tear film and space coordinates; Center: Tear film thickness at 160 ms after blinking for a full blink; Down: Tear film thickness at 160 ms after blinking for a half blink. Inside center and down images show a zoomed-in version.

and we observe the shift away from the eyelids in the upper lid portion of the tear film thickness, for both full blinks and half blinks. Half blinks improve the

thickness of the pre-lens tear film in the upper portion of the eye while decreasing it in the lower part, compared to full blinks. This could change the stability of the tear film affecting the patient's comfort of wearing the contact lens in situations with a high number of partial blinks (viewing electronic screens such as computers, mobiles, etc.). Moreover, the model permits an assessment of the dynamics of tear films for different patients because tear thickness curves are given as a function of time, which could help in the contact lens fitting process. Tear film dynamics for contact lens wearers could further be explored by modifying certain dynamics, such as complex contact lens motion.

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1.3. INTRAOCULAR LENSES AND REFRACTIVE SURGERY

Comparison of the estimated effective lens position and power lens with SRK/T, Hoffer Q, Holladay I and Haigis formulas in normal eyes

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Aim: The purpose of this study is to compare the estimated effective lens position (ELP) and the spherical power of intraocular lenses (PIOL) calculated with SRK/T, Hoffer Q, Holladay I and Haigis formulas and to compare the ELP with respect to the real anatomical position of postoperative lens (ALP).

Experimental method: This retrospective, observational study consisted of 30 eyes belonging to 30 patients who had already undergone uneventful phacoemulsification with IOL implantation by a single surgeon (FJCA) at Hospital Alcañiz. Inclusion criteria were the availability of preoperative ocular biometry measurements from Lenstar LS900 (Haag-Streit AG, Koenitz, Switzerland) and suitable for Alcon Clareon monofocal IOL (A-constant=119.1). Exclusion criteria were corneal astigmatism of over 2.00 diopters, previous ocular surgery, ocular trauma and the impossibility of IOL detection through the Lenstar optical biometer. Before surgery, all patients underwent a comprehensive preoperative examination that included 5 biometry measurements with Lenstar to know central corneal thickness (CCT), anterior corneal keratometry

(K), anterior chamber depth (ACD) and axial length (AL). The spherical power of the lens was calculated using the Barret Universal II to achieve emmetropia.

Patients were evaluated at least 3-4 weeks after surgery. The Lenstar biometry was performed postoperatively to determine the final position of the lens (ALP).

For data analysis, all the ocular parameters (biometry and keratometric data) of each patient were entered into a database developed by MATLAB (Mathworks Inc.) to calculate the mean values and standard deviations. Besides, the SRK/T, Hoffer Q, Holladay I and Haigis formulas were introduced to calculate P_{IOL} and ELP. Data analysis was performed by using R-Commander v.2-7. The normality of variables was evaluated via the Saphiro-Wilk test. The correlation between the values was evaluated with Pearson's test. The statistical significance was set at $p<0.05$.

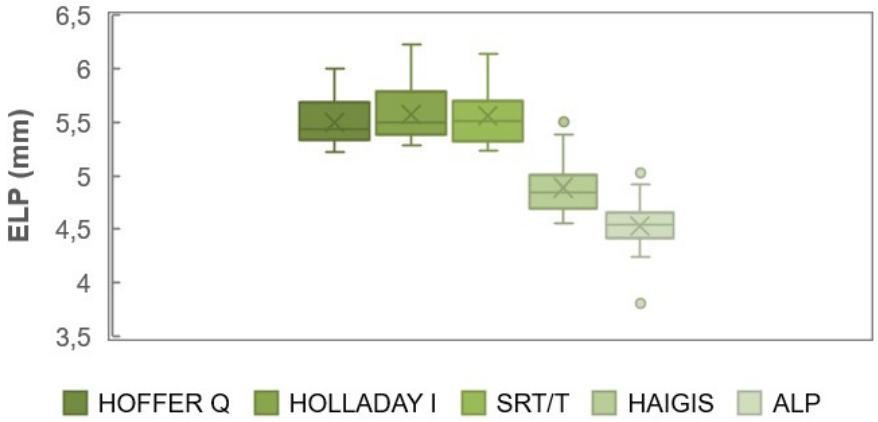

FIGURE 1. Comparison of ELP predicted with the Hoffer Q, Holladay I, SRK/T and Haigis formulas and axial intraocular lens position (ALP) measured with optical biometer Lenstar. ELP: Effective lens position; ALP: Anatomical lens position.

Results: A total of 30 eyes belonging to 30 patients were included in this study (mean age 75±9.28 years). The mean ELP ± SD predicted by Hoffer Q was 5.49 ±0.22 mm. With Holladay I it was 5.56±0.46 mm, with SRK/T it was 5.54±0.31mm, with Haigis it was 5.17 ±0.24 mm and with ALP it was 4.51±0.23mm (see Figure 1). The highest Pearson's correlation (cor) was between ELP, estimated by Hoffer Q and ELP by Haigis cor=0.910 (p-value<0.05). The minimum correlation is between ELP-SRK/T and ELP-Haigis cor=0.441(p=0.016). The ELP estimated by Haigis showed the highest correlation with ALP with a cor=0.331 (p=0.100), closely followed by the ELP, estimated by SRK/T cor=0.309 (p=0.094). The mean PIOL calculated with Hoffer was 21.59 ± 2.34 D. With Holladay I it was 21.49 ± 2.29 D, with SRK/T it was

21.65 ± 2.14 D, with Haigis it was 21.38 ± 2.24 D and with PIOL implanted, it was 21.89 ± 2.04 D.

Discussion: There are statistically significant differences between the ELP values estimated by the formulas used in this study and the ALP measured postoperatively. However, there are no statistically significant differences between the PIOL calculated by the different formulas.

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Optical performance of a new trifocal intraocular lens

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Aim: The purpose is to present a new intraocular lens design based on the Devil's staircase fractal function.

Experimental method: The diffractive structure of the lens is based on a triadic Cantor fractal [1].

The Liou-Brennan model eye (LBME) [2] was programmed in Zemax OpticStudio design software (v.18.7, LLC, Kirkland, WA, USA) to simulate the optical performance of the IOL under realistic visual conditions. Areas under the modulation transfer function (MTFas) curves were calculated at spatial fre-

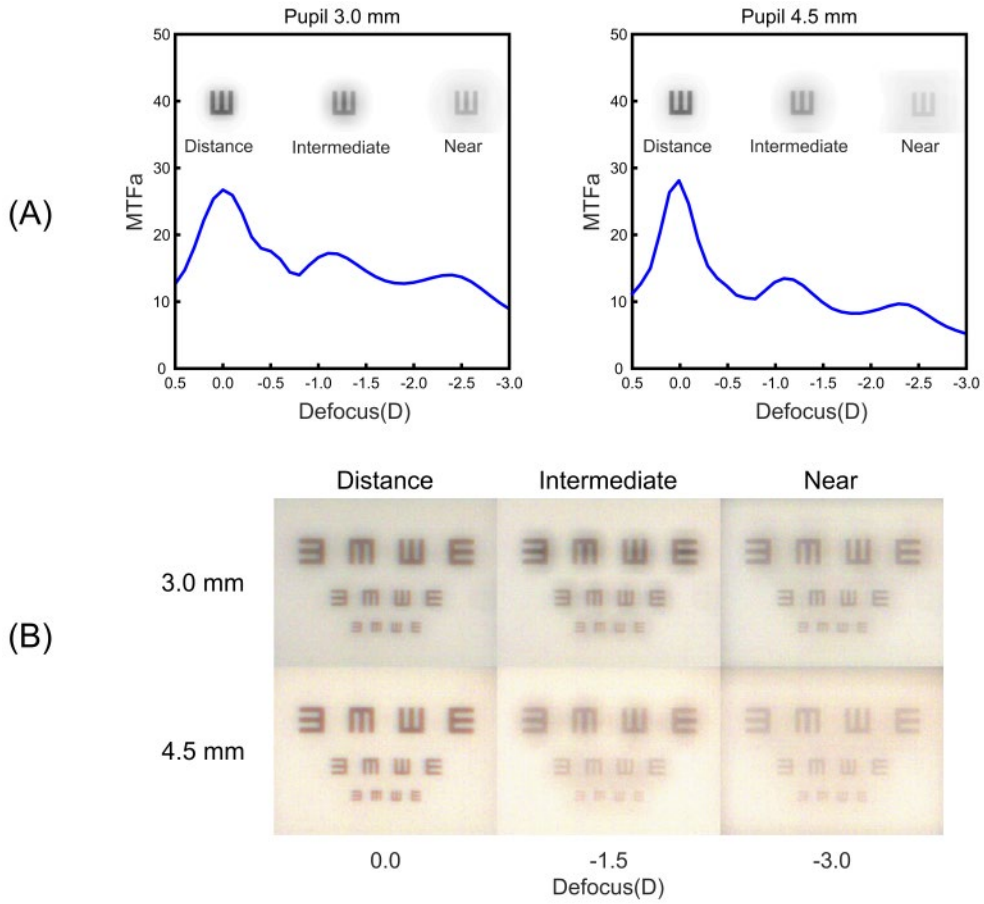

FIGURE 1. **A)** MTFas of the Devil IOL design and imaging simulation of a Snellen Es optotipe at pupil diameters of 3.0 mm and 4.5 mm and **B)** images at the main foci of the VAO simulation for both pupils.

quencies of between 0 and 50 lines/mm. This metric correlates with clinical visual acuity (VA) results [3]. Point spread functions (PSFs) were calculated at the focal planes and convolved with a Snellen Es optotype of VA 0.4 logMAR. All simulations were performed with a 550 nm green light for 3.0 mm and 4.5 mm pupil diameters to simulate photopic and mesopic pupils.

Experimental measurements using the visual adaptive optics simulator (VAO, Voptica SL, Murcia, Spain) were also performed [4]. The object used was a Snellen Es optotype of sizes corresponding to VAs of 0.4, 0.2 and 0.0 LogMAR. Images were captured at distance –, intermediate – and near-vision foci with a camera acting as an artificial eye. The optical perfor-

mance of the IOL was evaluated with polychromatic light for 3.0 and 4.5 mm pupil diameters.

Results: Figure 1(A) shows the MTFas. For both pupils, the MTFas were observed to have a trifocal profile where the performance for distance vision has the higher value.

Moreover, the Zemax simulations in the main foci and the images obtained with the VAO (Figure 1(A) and Figure 1(B)) agree with the results of the MTFas.

Discussion: Numerical and adaptive optics simulations are consistent. All optical performance images show good resolution with both pupils, with higher contrast in the far vision. It is possible to recognize the optotype at all distances for 0.0 logMAR VA.

The new Devil IOL design provides good optical performance results with a trifocal visual profile.

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Validation of a numerical model eye implemented in paraxial ray tracing software (OSLO) for cataract surgery

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Aim: The purpose of this study is to validate a numerical model of a pseudophakic eye implemented in a paraxial ray tracing software program (OSLO) as a complementary tool in cataract surgery.

Experimental method: This retrospective, observational study consisted of 30 eyes belonging to 30 patients who had already undergone uneventful phacoemulsification with intraocular lens (IOL) implantation by a single surgeon (FJCA) at Alcañiz Hospital. Inclusion criteria were the availability of preoperative ocular biometry measurements made with the Lenstar LS900 (Haag-Streit AG, Koenitz, Switzerland) and suitable for Alcon Clareon monofocal IOL (A-constant=119.1) implantation in a capsular bag and the absence of complications during or after cataract surgery. Exclusion criteria were corneal astigmatism of over 2.00 diopters, previous ocular surgery, ocular trauma, active ocular infection or inflammation and the impossibility of IOL detection through the Lenstar optical biometer.

Before surgery, all patients underwent a comprehensive preoperative examination that included 5 biometry measurements with the Lenstar and 2 measurements with an Oculus Pentacam topographer to characterize the anterior and posterior surface of the cornea. Patients were evaluated at least 3 weeks postoperatively. The subjective refraction was performed by the same experienced examiner. The numerical model of a pseudophakic eye was implemented with optical analysis software (OSLO) following these steps:

1) Design of Clareon IOL with a power range of between 16.50 D and 26.50 D and a spherical aberration on the anterior surface equal to –0.20 µm for a 6.00 mm diameter pupil entrance, following the manufacturer's specifications.

2) Modeling of all real eyes. Refractive index values of the Atchison model eye were used (1) and the anterior and posterior corneal radius of curvature were measured with a Pentacam preoperatively.

3) The IOL power (calculated with Barrett Universal II) to be implanted in each eye was introduced in every modeled eye. The final distance of the IOL was measured postoperatively (ALP) with the Lenstar LS900 biometer in "pseudophakic" mode, which indicates the actual position of the IOL after surgery.

Refractive error (ER_OSLO) was calculated with OSLO from the development of wavefront aberration through the Zernike coefficients corresponding to defocus, spherical aberration, oblique astigmatism and regular astigmatism. From these coefficients, the M, J0, and J45 components were calculated for a pupil diameter of 3 mm and finally the spherocylindrical refraction was calculated to obtain ER_OSLO. These values were compared with the real postoperative refractive error ER_SUBJ).

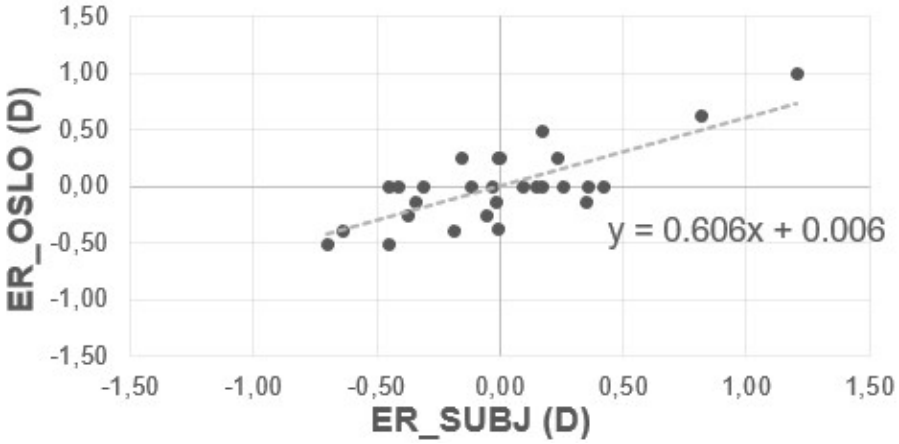

FIGURE 1. Correlation between ER_OSLO and ER_SUB.

Results: Figure 1 shows the ER_OSLO versus the ER_SUBJ. A linear regression between both ERs was obtained and the correlation coefficient, R2 and the slope, b, were computed. The correlation coefficient R2 was 0.571 and b was 0.606.

Discussion: OSLO is an interesting tool for performing postoperative simulations. It allows users to enter the anterior and posterior corneal radius (parameters that are not taken into account by most biometric calculators) and to vary the position of the lens to achieve emmetropia. It can also be used to evaluate the refractive repercussions that toric IOL rotations may cause.

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1.4. OPTICS AND INSTRUMENTATION

The Bebié curve for FDT perimetry

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Aim: The Bebié curve (BC) is a graphic diagnostic tool used by some perimeters that shows different patterns of sensitivity loss in the human visual field (VF). It displays sensitivity differences between the patient and the mean standard observer, sorted in decreasing order, and can detect and distinguish between diffuse and localized losses [1]. Its principal disadvantage is that it does not show where in the VF the loss has been produced. The Frequency Doubling Technology (FDT) perimeter, designed to detect damage in the magnocellular pathway [2], does not include this tool, although Johnson [3] analyzed its possible clinical application in the Matrix FDT perimeter. The purpose of this study is to define the normal range of the BC for classic FDT perimetry in a sample of young subjects and to compare the curve's loss detection performance with standard FDT parameters in numerically simulated pathologies.

Experimental method: The diagnostic performance of the BC was analyzed by simulating different pathologies by numerical methods, using FDT data collected from measurements with young patients. Inclusion criteria were having an age of between 20 and 30 years old, no systemic or ocular pathologies, ametropia under 2 diopters (D) and astigmatism under 1 D if corrected by ophthalmic lenses (although the FDT perimeter tolerates as much as a 6D defocus, we limited the range more as we were using a normal database), or below 6D if corrected by contact lenses (considered emmetropia), decimal visual acuity (VA) above 0.8 and normal contrast sensitivity function (CSF) for all the frequencies in Topcon's M-3 map (we considered CSF a detector test if there was any abnormality in the visual system, more precise than VA). We recruited 26 subjects, excluding three for presenting glaucoma, migraine and high myopia,

respectively. Subjects took the FDT C-20-5 screening test with the worst VA eye, for training, followed by the N-30 threshold test with the eye with best VA. The BC was computed using a MATLAB script, subtracting the patient's sensitivity at each point of the visual field and the mean sensitivity of the sample at that point and ordering the resulting values from highest to lowest. We simulated numerically diffuse loss, foveal loss, nasal and temporal hemianopsias, upper and lower altitudinal defect, quadrantanopsia, peripherical loss, central loss and central plus diffuse loss by reducing the sensitivity at each point of the affected area by the same amount. A normal database for our sample was also defined for the difference map (DM), the mean defect (MD) and the pattern standard deviation (PSD). The 5% percentile was used in all parameters as a normality criterion.

	BC	DM	MD	PSD
Diffuse loss	6	5	8	
Nasal hemianopsia	7	5	15	5
Temporal hemianopsia	9	8	18	8
Upper altitudinal Defect	9	6	16	7
Lower altitudinal Defect	8	5	16	6
Inferior Nasal Quadrantanopsia	9	5	29	7
Superior Nasal Quadrantanopsia	9	6	29	6
Inferior Temporal Quadrantanopsia	9	8		8
Superior Temporal Quadrantanopsia	11	8		9
Peripherical Loss	8	6	12	7
Central Loss	9	5	29	7
Diffuse + Central Loss	6	2	17	7

TABLE 1. Minimum detectable sensitivity loss (dB) for each parameter. Empty cells indicate that the parameter does not detect the damage. BC=Bebie Curve; DM=Difference Map; MD=Mean Defect; PSD= Pattern Standard Deviation.

Results: To compare the diagnostic performance of the different diagnostic tools, we determined the minimum amount of sensitivity loss needed for the DM, BC, MD and PSD to be out-of-normal limits (Table 1). In all the simulated pathologies, the difference map was the most sensitive representation, so in what follows we compare only the three remaining parameters. For diffuse loss, the PSD was unable to detect the damage and the BC detected earlier than the MD. All the types of localized loss were detected earlier by the PSD, followed by the BC, with the MD only detecting a greater loss (>12dB), if at all. With diffuse + central loss, however, the BC detects the loss earlier than PSD.

Discussion: We could define the normal range of the BC for classic FDT perimetry, and to compare the BC with other parameters. According to the literature, the BC gives similar results to the PSD in concrete losses and improves in diffuse losses [1-4], but in our database it is better as is more specific [3]. The MD can be better [3, 4], but the BC is a graphic that is easy to understand [4] and a complement to clinical procedures.

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Changes in choroidal and retinal thickness assessed by optical coherence tomography in type 2 diabetes mellitus patients with moderate diabetic retinopathy

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Aim: To study choroidal thickness (CT) in type 2 diabetes mellitus (DM2) patients with moderate diabetic retinopathy (DR) without diabetic macular edema (DME) and to correlate with changes in retinal thickness (RT) with swept source OCT (SS-OCT) compared to healthy subjects.

Methods: Fifty-four DM2 patients with moderate DR without DME and 73 age-matched healthy subjects were evaluated using SS-OCT to measure changes in the total RT and the CT in the 9 Early Treatment Diabetic Retinopathy Study (ETDRS) macular areas [1]. Exclusion criteria for both groups included amblyopia or best corrected visual acuity (BCVA) of less than 20/40 on the Snellen chart, refractive error over ± 5.50 diopters (D) of spherical equivalent (SE) or 3.00 D of astigmatism, intraocular pressure (IOP) higher than 20 mmHg, history of any ocular pathology affecting central vision, ocular hypertension or glaucoma with perimetric involvement or papillary atrophy or the inability to perform good quality OCT. All patients underwent a complete visual examination, including BCVA,

IOP measured by Goldman tonometry, axial length (AL) and SS-OCT. In addition, a complete history with clinical variables was performed. In statistical analysis, the Mann-Whitney U test was performed for independent nonparametric samples to assess if there were statistically significant differences between the groups, considering a value of $p<0.05$ as statistically significant.

Results: The mean ages were 64.06 ± 11.98 years and 60.79 ± 8.62 years in the diabetic and control groups, respectively. Visual acuity (VA) with ETDRS 100% was lower in the DM2 patients ($U=1329.00$; $p<0.001$). In the total RT, statistically significant differences were found in the temporal external area being thicker in the DM2 group (260.70±19.22 µm vs 271.90±37.61 µm with $U=1262.50$; $p=0.010$, in control and DM2 group, respectively). The CT did not show significant differences between both groups ($p>0.05$) in any ETDRS area. There was a significant negative correlation between RT and age in all the external ETDRS areas and a positive significant correlation in the central area for the DM2 group. There was also a negative significant correlation between CT and age in all ETDRS areas except for the inferior inner area. In the DM2 group, a negative correlation was observed between RT and CT in the central area ($rs=-0.287$; $p=0.039$) and in both horizontal parafoveal areas (temporal inner: $p=0.028$, central: $p=0.039$ and nasal inner: $p=0.003$).

Discussion: Choroidal and retinal layers undergo changes due to DM progression, especially in patients with poor glycaemic control and with longer evolution time. In addition to the choroidal and retinal changes, there are many visual changes with the disease evolution, such as BCVA, getting worse as the pathology progresses [2, 3].This study shows that DM2 patients with moderate DR have no changes in CT in comparison with normal age-matched controls. CT and RT decrease with age and show a negative correlation with RT in the central and horizontal parafoveal ETDRS areas [4-6]. Our results are consistent with those found in the literature. Future studies will be required to confirm these findings with a larger sample of diabetic patients and with different DR stages and with both DM1 and DM2, since their behavior can be different, influenced by age, time of DM evolution and other factors.

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Clinical evaluation of the repeatability and variability of ocular aberrometry with different target vergences

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Aim: This study aims to evaluate the within-session repeatability of ocular aberrations when the accommodation is monocularly stimulated.

Experimental method: The study included 16 right-health eyes from 9 females and 7 males, young Caucasian subjects aged 20 to 33. None of the subjects had any ocular pathology or had undergone any refractive surgery. Accommodative stimulation was induced by the in-built stimulus of a Hartmann-Shack aberrometer irx3 (Imagine Eyes, France) [1].

The monochromatic aberrations were measured with a natural pupil in dim room illumination for accommodative demand range between 0.0 D to 5.0 D in 0.50 D steps. For each step, three repeated measures were obtained, making thirty-three measurements in total for each subject, lasting about 2 seconds for each measure. Data were rescaled to a 4 mm pupil size, reported as individual Zernike coefficients, and expanded to the 6th order. Statistical analysis on repeatability and variability were done based on the variance (S^2_w) of the three repeated measurements, in coefficients of repeatability (CR) and coefficients of variation (CV) [2].

Results: The mean and within Sw for all target vergences were calculated. All Zernike coefficients showed high repeatability, ***CR*** < **0.05**, except for the defocus coefficient, **Z** (**2**,**0**), ***CR*** > **1.85**. The coefficient of repeatability increased with accommodative demand in the defocus, (Pearson correlation coefficient $r = 0.985$, ***p – value*** < **0.01**).

Overall, there was variability in the data if we look at each Zernike coefficient for each accommodative vergence. The **Z** (**2**,**0**) increased the percentage of variability when the target vergence increased, from 0.63% to 21.84%. However, a decrease in variability was observed with increasing target vergence in **Z** (**2**,**2**) (from 79.55% to 3.12%), **Z** (**2**,**-2**) (from 67.12% to 4.56%), **Z** (**4**,**0**) (from 5.85% to 1.54%) and **Z** (**6**,**0**) (from 11.89% to 1.37%).

Discussion: It should be noted that an increase in repeatability has been observed with accommodative demand and a decrease with the order of the coefficients, in agreement with other repeatability studies [3, 4]. Studies on repeatability of Zernike coefficients with accommodation [5-7] reported higher variability in the population for the coefficients **Z** (**2**,**-2**), **Z** (**2**,**2**) and **Z** (**3**,**-1**), with values greater than 60%, while the defocus **Z** (**2**,**0**), spherical aberration **Z** (**4**,**0**) and second-order spherical aberration **Z** (**6**,**0**) showed weaker variability (***CV*** < **40%**).

Conclusion: This aberrometer gives us large variability in the different Zernike coefficients for the different vergences measured. This variability may be due to fixation errors, operator dependency or microfluctuations in accommodation [8], tear film instability [9] and small fixation eye movements [10]. It must be kept in mind that the measures carried out under these conditions have some level of inconsistency.

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Comparison between clinically measured insert versus theoretical and standard value and its importance in progressive addition lens adaptation

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Aim: Inset is the horizontal distance between far and near vision zones in progressive addition lenses (PALs) and is an important parameter in users' PALs adaptation.[1] However, inset is usually calculated based on theoretical calculations (with the center of the pupil as the point of reference) or directly assigned with a standard value (commonly 2.5 mm). Recently, a new method called the Ergofocus® system, (Lentitech Inc, Spain) has been developed to measure the foveal fixation axis (FFA) line, which directly links to the fixation point and the fovea [2], to provide a point to centre the ophthalmic lens at far and near distances that can clinically measure the real inset value. The aim of this study was to compare the theoretical, standard (2.5 mm) and clinically measured inset with FFA and analyze its importance in users' PALs adaptation.

Experimental method: Seventy-one presbyopic patients, classified in four groups according to their previous use of PALs (dropout group, uncomfortable PALs users, comfortable PALs users and neophytes) were included in the study. Theoretical inset was calculated using the HoyaiLog system (HOYA Inc, Japan) for a LifeStyle 3i lens prescription using facial and frame parameters measured individually in every patient. The value for standard inset was 2.5 mm. FFA distance was measured with the Ergofocus® system (Figure 1), which comprises two moveable stenopeic slits located in front of each eye (one horizontal and one vertical). These slits were moved to the patient fixation point in far and near distance and the device provided both distances and inset value as the difference at the PALs prescription plane. Statistical analysis was performed using the SPSS 24.0 (SPSS, Chicago, USA) statistical package for Windows. The non-parametric data distribution was verified with the Kolmogorov-Smirnov test. The Wilcoxon non-parametric paired test was used to compare the different insets.

Results: Right and left FFA inset (1.45±1.19 and 2.21±1.48mm) showed statistically significant differences with theoretical inset (2.55±0.61 and 3.39±0.68mm)

(P<0.01) in both eyes. Just the right eye FFA inset and left eye theoretical inset were statistically different from the standard inset (P<0.01). Meanwhile, left the eye FFA inset (P=0.09) and right eye theoretical inset (P=0.52) did not show significant differences with the standard inset. Regarding study groups, comfortable PALs users showed non-significant differences between FFA, theoretical and standard inset in both eyes (P>0.05). Moreover, uncomfortable PALs users and dropout groups showed significant differences between FFA inset, theoretical and standard inset in both eyes (P<0.05).

FIGURE 1. Device for FFA distance measurement.

Discussion: Clinically measured FFA inset is different from standard and theoretical inset, especially in patients who are unable or have trouble adapting to wearing PALs. However, comfortable PALs users showed no differences between different calculated inset values. These results suggest that a clinically measured inset could help in patients' adaptation process with a physiological inset farther from the standard or theoretical inset values. More studies are necessary to analyze the inset variation in adapting to using PALs.

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Contrast speckle as a retinal tissue integrity biomarker in patients with type 1 diabetes mellitus with no retinopathy

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Aim: To study the retinal and choroidal layers of subjects with type 1 diabetes mellitus (DM1) without diabetic retinopathy (DR), using speckle contrast of spectral-domain optical coherence tomography (SD-OCT) images as a tissue biomarker in comparison with healthy subjects. [1].

Experimental method: SD-OCT Spectralis images of 148 eyes were collected, 84 from DM1 patients without DR signs and 64 belonging to the control group. Interferometry, the measurement technique on which OCT is based, gives rise to speckle, which has been considered a form of noise that degrades the quality of the OCT image. However, OCT speckle can also be signal-carrying and be used to infer about the micro-structure of the tissue. [2] In this context, the contrast speckle of the inner retinal layer (IRL), the outer retinal layer (ORL) and the choroidal layers in the nasal parafoveal area (N3) was estimated as the ratio between mean pixel intensity and its standard deviation and analysed using custom made software. In addition, the IRL, the ORL and the choroid thicknesses were obtained from the SD-OCT Spectralis software version 6.8.1.0. in the same N3 area. Statistical analysis was performed using Microsoft Office Excel (Microsoft Office Professional Plus 2016; Microsoft; Redmond, WA, USA) and SPSS version 25.0 statistical software (SPSS Inc., Chicago, IL, USA). Normality was not rejected for each data set (Shapiro-Wilk test, $p>0.05$). The paired two-sample Student's t-test and the coefficient of determination (R^2) were used to investigate the differences between the right and left eyes of both groups.

Results: The right eye (OD) and the left eye (OS) of each patient were compared, each one within their study group, with no statistically significant differences (both $p>0.05$). A statistically significant difference ($p=0.001$) in the IRL thickness between groups was observed, being thicker in the DM1 group. There were no differences in the ORL and choroidal thicknesses between groups. The same comparison between groups was performed with the speckle contrast per

layer, again observing a statistically significant difference (p=0.02) in the IRL speckle contrast, being lower in the DM1 group compared to the control group. The maximum speckle contrast was reached in the ORL for both groups, although in the control group, the maximum speckle occurs at an ORL depth of 58 ± 9 µm, while in the DM1 group the maximum speckle occurs at a deeper position, closer to the choroid, at 64 ± 8 µm. This difference is statistically significant (p=0.008).

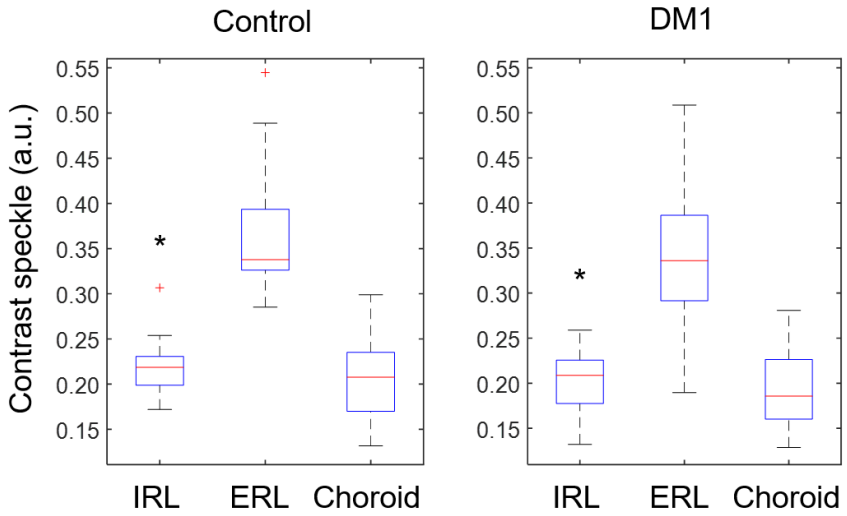

FIGURE 1. Box plot representing the speckle contrast in arbitrary units (a.u.) for the control group (n=64), and for the DM1 group (n=84) for each layer under study (IRC, CER and choroid). Data was obtained by calculating the mean speckle contrast value for each participant and for each layer. Results marked with an asterisk (*) indicate a statistically significant difference between groups.

Discussion: Statistically significant differences were found in speckle contrast between the control and the DM1 group without DR signs. The differences observed are currently of no clinical importance as determined by a retinal ophthalmologist. Still, they suggest an alteration in the retinal tissue of DM1 patients, especially at the IRL level, so close follow-up of patients with this pathology would be recommended. This finding (decreased speckle contrast in DM1) could support the IRL neurodegeneration before DR signs are observed. [1].

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Repeatability of bulbar redness measurements obtained using the Keratograph 5M

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Aim: The Tear Film and Ocular Surface Dry Eye WorkShop II reported in 2017 that diagnosing dry eye disease is a challenge, partially due to the low repeatability of some metrics used for assessing the ocular surface [1]. Therefore, this study aims to assess the intraexaminer repeatability of bulbar redness metrics obtained using the Keratograph 5M.

Experimental method: Thirty eyes from 30 healthy subjects (Mean±Standard deviation: 31.1±10.3 years) were enrolled in this study. Bulbar redness was objectively assessed three consecutive times through the Keratograph 5M. Conjunctiva must be adequately focused and an image of 1156 x 873 pixels and at 96 dpi was created and displayed on the computer screen. The device automatically detected the bulbar conjunctiva and measured bulbar redness depending on the zone as the ratio between conjunctiva vessels (red) and sclera (white) with an accuracy of 0.1 units. Thus, the bulbar redness scores ranged from 0.0 to 4.0 in each zone: temporal bulbar, nasal bulbar, temporal limbal, nasal limbal and total bulbar redness [2, 3]. Repeatability was assessed for each metric by the coefficient of variation (CoV) [4, 5]. The Friedman test was used to compare the three measurements.

Results: Table 1 shows the repeatability coefficient for each metric. CoV showed values near 0 for all metrics, with values between 10.92 and 28.57%. The highest repeatability was obtained in total bulbar redness (CoV=10.92%). The Friedman test revealed that the third measurement was slightly higher than the others ($p<0.045$).

Metric	CoV (%)	First (Mean±SD)	Second (Mean±SD)	Third (Mean±SD)	p-value	Post-hoc
Temporal bulbar redness	13.02	0.70±0.24	0.73±0.25	0.77±0.29	0.045[1]*	1-2=0.422[2] 1-3=0.018[2]* 2-3=0.06[2]
Nasal bulbar redness	14.28	0.74±0.32	0.75±0.31	0.79±0.35	0.044[1]*	1-2=0.516[2] 1-3=0.015[2]* 2-3=0.07[2]
Temporal limbal redness	22.12	0.36±0.25	0.36±0.29	0.4±0.31	0.040[1]*	1-2=0.489[2] 1-3=0.014[2]* 2-3=0.08[2]
Nasal limbal redness	28.57	0.31±0.20	0.34±0.26	0.39±0.29	0.028[1]*	1-2=0.543[2] 1-3=0.008[2]* 2-3=0.010[2]*
Total bulbar redness	10.92	0.72±0.24	0.73±0.26	0.77±0.30	0.030[1]*	1-2=0.524[2] 1-3=0.017[2]* 2-3=0.025[2]*

TABLE 1. Repeatability of ocular redness measurements.
[1] Friedman test; [2] Bonferroni; * Statistically significant.

Discussion: Measurements are fast (3 seconds per each measurement); however, white light might have increased the redness of the ocular surface in the third measurement. Infrared light could be used as a possible improvement. Despite the comparison between the three measurements being statistically significant, it was not considered clinically significant. Keratograph 5M can be used as an objective tool with acceptable repeatability for assessing bulbar redness, which could help in the diagnosis of some diseases related to ocular surface inflammation, such as dry eye disease or uveitis.

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Zemax OpticStudio toolbox as a method for visual quality analysis in multifocal contact lenses

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Aim: The purpose of this study is to explore Zemax OpticStudio as a toolbox to analyze the visual quality of optical systems such as multifocal contact lenses for presbyopic patients. The Visual Strehl ratio (VSOTF) for on-axis and off-axis objects and for different aperture diameters were studied. Moreover, Zemax opens the possibility of assessing more visual merit figures (aberrations, spot diagrams, image simulation, distortion etc.) not usually given for multifocal contact lens evaluation, specially for changes in the visual field.

Experimental method: A multifocal contact lens with centre-near design was simulated in Zemax OpticStudio. As developed in previous scientific articles which only take the wavefront coming out from the lens into account [1], a study of VSOTF was performed, with the difference that we also analyzed an off-axis object at 20º and higher fields and far distance. The sagittal data (vertical field

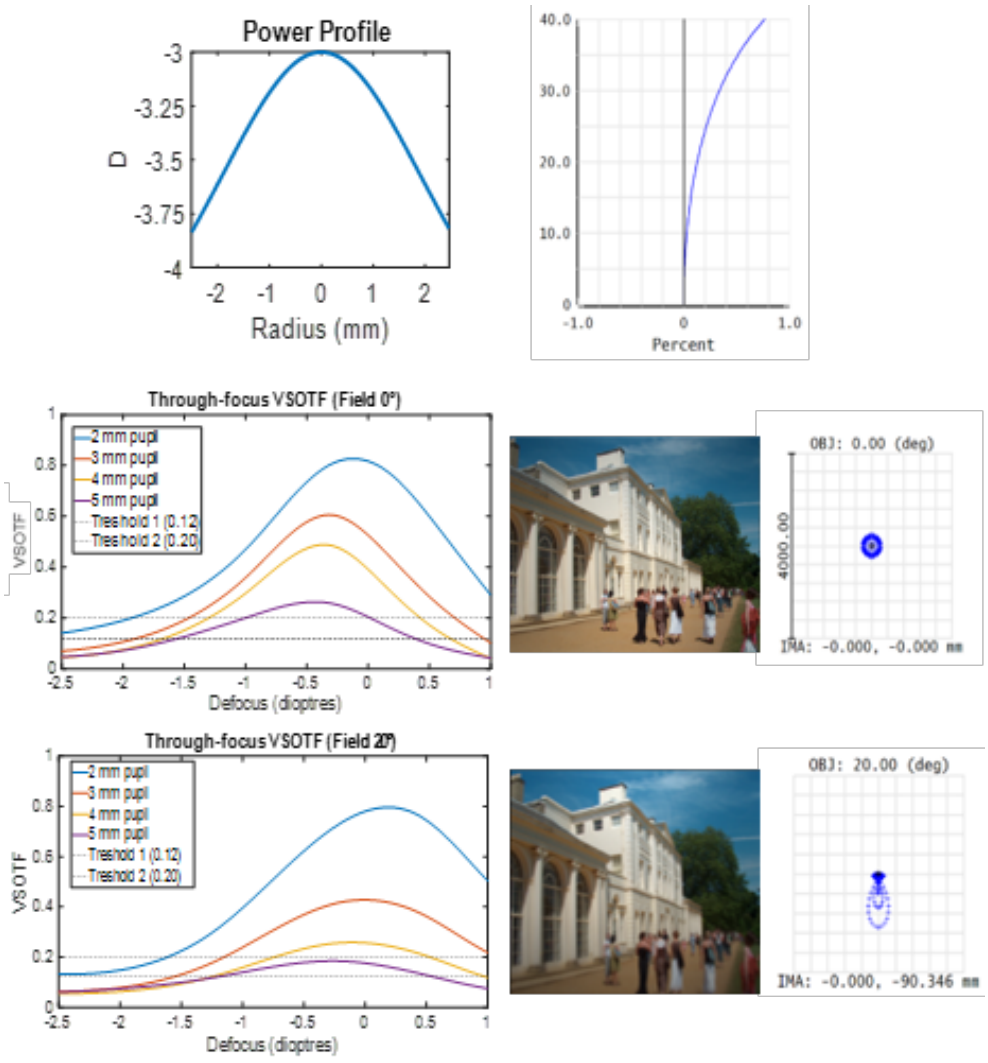

FIGURE 1. Image quality results. Power profile and distortion with field (top), VSOTF for several pupils and object field (left, 0º and 20º), image simulation (image size 20º, center for image centered at 0º, bottom centered at 20º), and spot diagrams (right column).

deviation) of the modulation transfer function via fourier transform (FFT-MTF) was obtained from Zemax for several distances and aperture diameters. Afterwards, the data were transferred to Matlab, where the VSOTF formula was calculated, taking into account a nominal contrast sensitivity function [2]. Several quality curves were displayed. At the same time, the optical aberrations of the system, such as the Optical Path Difference (OPD), Ray Fan, spot diagram and

image simulation were studied and compared for on-axis and off-axis objects with Zemax OpticStudio [3].

Results: The results from the quality analysis are depicted in Figure 1. The method evaluates different pupil diameters easily. On axis, the VSOTF curves for all the pupil diameters are above the ocular FFT-MTF threshold, considered 0.2. In the off-axis analysis (field of 20º), the real prescription of the lens changes by around 0.25 diopters. For fields from 20º to 40º, it changes by 0.11D per field degree. The maximums of the VSOTF decrease and the curves are displaced to the left as the pupil gets bigger for both on-axis and off-axis representations. From 0º to 40º, the maximum of VSOFT decreases by 17.65%, 34.8% and 44.4% for 2,3,4 mm diameter, respectively. Image quality and spot diagrams show an increase of aberrations with the field not normally reported. Distortion curves were also studied (0.2% at 5º and 0.76% at 40º).

Discussion: The results show image quality and prescription changes with the object field that could vary among different lens design analyses. The increase of aberrations with field extends the depth of focus and change the image quality (see Figure 1). Zemax OpticStudio provides more merit figures than usually reported, especially variations with field of view that could be very interesting in multifocal contact lens design for presbyopic applications.

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1.5. BINOCULAR VISION

Analysis of the Hess Lancaster screen test with eye-tracker

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Aim: To objectively measure the coordination and gaze direction of both eyes in different positions when performing the Hess Lancaster screen test monitored with an eye-tracker in a sample of control subjects without binocular dysfunctions.

Experimental method: In this study, 59 subjects between the ages of 18 and 27 underwent a complete optometric examination in which refractive error, accommodation, vergences, measurement of the horizontal and vertical phoria with the Maddox rod test, oculomotricity and sensory state of vision were assessed. Subjects who suffered from suppression of one of the two eyes, visual acuity of less than 0.8 in each eye, strabismus or any symptom of binocular dysfunction that could alter the results were excluded. After optometric evaluation, there were 29 participants without binocular problems who underwent the Hess Lancaster screen test wearing anaglyph glasses. While performing this test, the examiner wrote down each of the points on a template in a traditional way, while the eye-tracker (Tobii Pro Fusion, Tobii AB, Sweden), placed in front of the subject, took objective measurements of the position of both eyes at each point. A specific program called Etracker Parse video (University of Zaragoza, Spain) was developed to analyse the prismatic deviation between both eyes at each evaluated point.

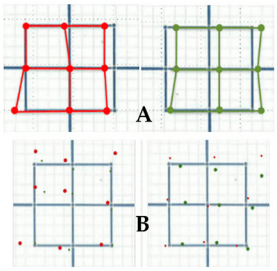
Results: The results of horizontal prismatic deviation between visual axes in the different gaze positions are quite similar between the values obtained with the Maddox rod, the manual annotated Lancaster screen and the eye-tracker measurement, but variations can be found in the magnitude of the deviation between

one and the other, although not in the direction (if there is endophoria, it is detected as endophoria in all three cases) (Table 1). On the other hand, vertical deviations are more difficult for the examiner to detect and quantify, obtaining different values when measuring objectively with the eye-tracker, especially when it comes to small magnitudes, as was the case in this study (Table 2).

Discussion: None of the tests is diagnostic by itself, but they all are complementary to the rest of the optometric tests that would be carried out in a binocular vision examination. The possibility of objectively measuring the prismatic deviation that exists between visual axes while performing the Hess Lancaster screen test through an eye-tracker represents progress, especially in detecting vertical deviations, which are more difficult to detect subjectively by the examiner. As such, the eye-tracker is an objective method with which it is possible to evaluate the Hess Lancaster screen test in patients with no binocular problems, obtaining more accurate results than when it is performed subjectively.

Subject 1

Maddox Rod Phoria	DV	IV
Horizontal	Orthophoria	Orthophoria
Vertical	Orthophoria	1 Δ BU RE



	Examiner				Eye–Tracker			
	Δx LE	Δy LE	Δx RE	Δy RE	Δx LE	Δy LE	Δx RE	Δy RE
1	0.00	0.00	−5.00	0.00	−4.02	1.42	−6.08	−0.75
2	0.00	0.00	−5.00	0.00	−4.76	2.08	−9.13	1.22
3	0.00	0.00	−5.00	0.00	−3.17	4.30	−5.48	3.69
4	−2.50	0.00	−5.00	0.00	−4.23	4.32	−1.03	6.03
5	−5.00	0.00	−5.00	0.00	1.81	8.57	−1.03	9.57
6	−5.00	0.00	−3.75	0.00	−2.25	3.28	−2.62	4.64
7	−3.75	0.00	−5.00	0.00	−5.47	−0.10	−5.80	1.36
8	0.00	0.00	−5.00	0.00	−4.78	0.74	−6.60	0.20
9	−6.25	0.00	−2.50	0.00	−7.45	−0.15	−8.61	−1.00

TABLE 1. Above is a first table with the subjective data of the values of the horizontal and vertical phoria measured with the Maddox rod test for both distance vision (DV) and intermediate vision (IV). Below to the right is another table with the data, both objective (the fixations collected by the eye-tracker from the 9 central points of the Hess Lancaster screen test) and subjective (estimated deviations after the manual data collection by the explorer and reflected in the Hess Lancaster test template), in both cases horizontal (Δx) and vertical (Δy) deviations for each eye. On the left, above, is the represented result of the Hess Lancaster screen obtained manually (red for the LE and green for the RE (illustration A)) and just below the representation of the points obtained with the eye-tracker (red points for the LE and green for RE (Illustration B).

Examiner vs. Eye tracker values	Differences (p)	Correlation coeficient (cc) (p)
Δx LE	<0.001	0.401 (<0.001)
Δy LE	0.815	0.002 (0.983)
Δx RE	<0.001	0.527 (<0.001)
Δy RE	0.650	0.034 (0.716)

TABLE 2. Differences related between the measurements and the correlation coefficient (cc) obtained when comparing the results of the horizontal (Δx) and vertical (Δy) deviations collected subjectively by the examiner versus the objective ones by the eye-tracker in a sample size of 117 measurements (9 points from 13 subjects). A value of p<0.05 was considered statistically significant.

Use of contact lenses in patients with anisometropic amblyopia without strabismus

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Aim: The aim of the study was to assess binocular vision, ocular alignment and visual acuity before and after the use of contact lenses in patients with anisometropic amblyopia.

Experimental method: A prospective pre-post quasi-experimental study was performed with 8 patients with anisometropic amblyopia between 6 to 56 years (mean: 27.6; SD: 20.24; median: 24 years, 50% males and 50% females, Anisometropic Power Mean: 3.44; SD: 1.31; median: 3.50). The study was approved by the Medical Ethics Committee of Alicante Hospital and followed the principles of the Declaration of Helsinki. A baseline examination was performed before contact lens fitting, including analysis of stereopsis, visual acuity and ocular alignment. After this, the contact lens Horizon Bio (Tiedra Farmaceutica SL) was fitted following the manufacturer's guidelines. The patient wore the lenses for 4 to 6 weeks and the same evaluation as in the baseline assessment was performed. For the analysis of binocularity, the concept of binocular function score (BF) was used [1], which combines the results of the Worth 4 dot test [2-3] and stereopsis measurements [4-6].

Results: The results that we obtained in the changes of the BFs of distance (Figure 1) and near with the lateral disparity stereopsis test were statistically significant (p=0.016), while it was not achieved in BFs with the use of the Random Dot test at near vision (p =0.079). Changes in visual acuity at far distance (p=0.344) and near distance (p=0.250) were not statistically significant. As for the ocular alignment measured before and after the use of contact lenses, no statistically significant changes were achieved either in the horizontal distance (p=0.187) and near distance (p=0.719), and much less changes in the vertical phoria in far distance (p=0.500) and near distance (p=0.999). Only lens breakage has been reported as a side effect in learning to wear contact lenses.

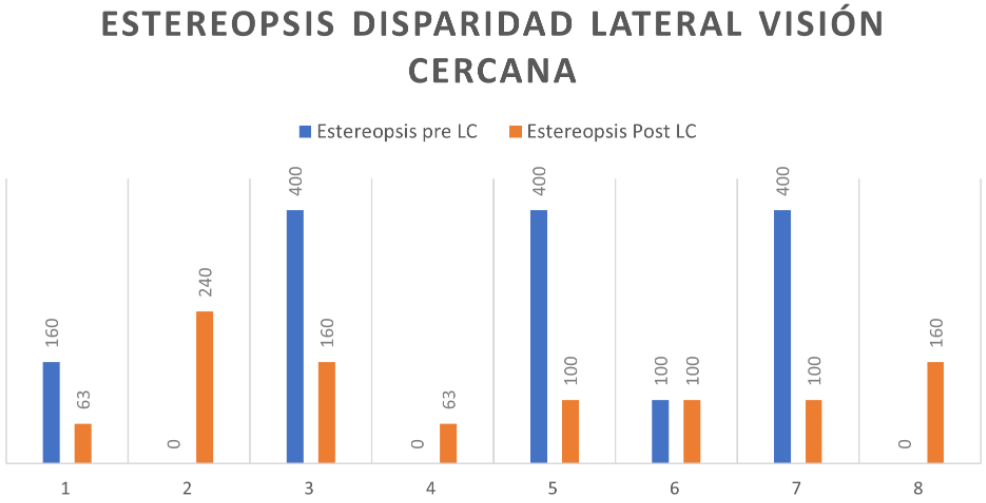

FIGURE 1. Comparison between stereopsis in lateral disparity before and after the use of contact lenses in each patient at far distance.

Discussion: The use of contact lenses is a first step in the treatment of anisometropic amblyopia, but it should be combined with other treatments to improve its effectiveness. We cannot compare the results of this study with any other due to the scanty published scientific evidence [7-10], since it is old and not related to stereopsis. More studies are needed to compare its effectiveness and compare it with the use of other types of lenses such as rigid lenses or in combination with other treatments such as vision therapy, virtual reality or the dichoptic method.

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1.6. REHABILITATION, PERCEPTUAL TRAINING AND VISUAL THERAPY

Fusional vergence dysfunction associated with accommodative insufficiency

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Aim: The objective of this study is to present a clinical case of an 8-year-old patient with symptomatic fusional vergence dysfunction, accommodative insufficiency and oculomotor dysfunction.

Experimental method: The patient was referred by the ophthalmology service of the Miguel Servet University Children's Hospital for a complete review of the visual system. She had frequent headaches and had often complained of pain and blurred vision for a few weeks, especially in the RE. After evaluation, she was diagnosed with fusional vergence dysfunction, accommodative insufficiency and oculomotor dysfunction. She also showed an inability to perform vergence jumps, with prismatic flippers of 4 / 14Δ. We also highlight a remote PPC, a low ARN and low accommodative flexibility. During the examination, high values of exophoria were also obtained. The patient presented a hyperphoria of 1 Δ in the RE. Moreover, we found an inability to stimulate accommodation and low amplitude of accommodation. Lastly, oculomotor dysfunction was demonstrated in the inability to perform more than three complete cycles in NSUCO for saccades.

Results: A 21-session vision therapy program was carried out at the university clinic, complemented by exercises performed by the patient at home. During the therapy program, the sequence was as follows: monocular, biocular and binocular. Accommodative, vergences, motility, anti-suppression, eye-hand coordination and peripheral vision exercises were performed. The results of the optometric evaluations carried out before and after the treatment and the normal ranges are shown in Figure 1. After the vision therapy program, the patient's symptoms disappeared; she did not report headaches, eyestrain or asthenopia. The treatment was completed after 21 sessions, because although the symptoms were lessened, the program ended when the different visual skills were automated. On the other hand, each patient is different and in this case the age of the patient could have an influence, as well as their cooperation in the exercises performed.

	BEFORE			AFTER			NORMAL VALUES
VA nv	RE: 0.5	LE: 0.6	BE: 0.6	RE: 1	LE:1	BE:1	1
NPC	17/28 cm			1/5 cm			< 6 cm
SACCADIC MOVEMENT	Ability: 3			Ability: 5			Ability: 5
	Precision: 1			Precision: 3			Precision: 3
COVER TEST	10.92	0.72±0.24	0.73±0.26	FV: 6ΔExo	NV: 12ΔExo		1 Δ Exophoria
MADDOX TEST	H	FV: 4ΔExo	NV: 3ΔExo	FV: 4ΔExo	NV: 6ΔExo		1 Δ Exophoria
	V	FV: 1ΔH RE	NV: 1ΔH RE	FV: ORTHO	NV: ORTHO		
PFV	FV:6/0		NV:10/0	FV:20/18	NV:30/20		FV:11/7 NV:19/14
VF (4/14 Δ)	FV:0 cpm		NV:0 cpm	FV:12 cpm	NV:12 cpm		11 cpm
AF	RE: 4.5 cpm		LE:5 cpm	RE:15 cpm	LE:17 cpm		11 cpm
AA (Donders)	RE: +5.75 D		LE: +8.25 D	RE: +16 D	LF: +16.25 D		
NRA/PRA	+2.00 D/-1.50 D			+2.25 D/ >-3.00 D			+2.50 D/ -2.50 D
MEM	+1.25 D BE			+0.75 D BE			+0.75 D

TABLE 1. Pre-treatment and post-treatment subjective clinical measures and normal range. VA: visual acuity; NPC: near point of convergence; AA: amplitude of accommodation; RE: right eye; LE: left eye; PFV: positive fusional vergence; VF: vergences flexibility; AF: accommodative flexibility; NRA/PRA: negative relative accommodation/positive relative accommodation; MEM: monocular estimation method.

Discussion: Regarding the dysfunction of the fusional vergences, the efficacy of visual therapy as a treatment has scarcely been studied at present, with little scientific evidence to support the results obtained in this clinical case. However, we can find a study by Daum of 34 healthy asymptomatic young adults in which an increase in the range of fusional vergences was demonstrated, performing different visual therapy exercises [1]. Regarding accommodation problems, multiple studies assess the efficacy of TV as a treatment. A randomized clinical trial published in Optometry and Vision Science in November 2011 showed that after 12 weeks of visual therapy treatment, higher values of accommodation amplitudes were obtained, as well as improvement in accommodative flexibility. Finally, regarding oculomotor dysfunctions, we cannot find as many studies that demonstrate the effectiveness of vision therapy as a treatment. But there are clinical cases and trials in which improvement in these abilities is demonstrated after completing vision therapy treatment. Jafarlou et al. analyzed the effectiveness of this treatment as oculomotor rehabilitation in dyslexic children. They found greater control of oculomotor skills and eye movements after treatment. [3].

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NUTRARET: Effect of two-year nutraceutical supplementation on redox status and visual function of patients with retinitis pigmentosa: a randomized, double-blind, placebo-controlled trial

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Aim: Oxidative stress plays a major role in the pathogenesis of retinitis pigmentosa (RP). The main goal of this study was to evaluate the effect of two-year nutritional intervention with antioxidant nutraceuticals on the visual function of RP patients.

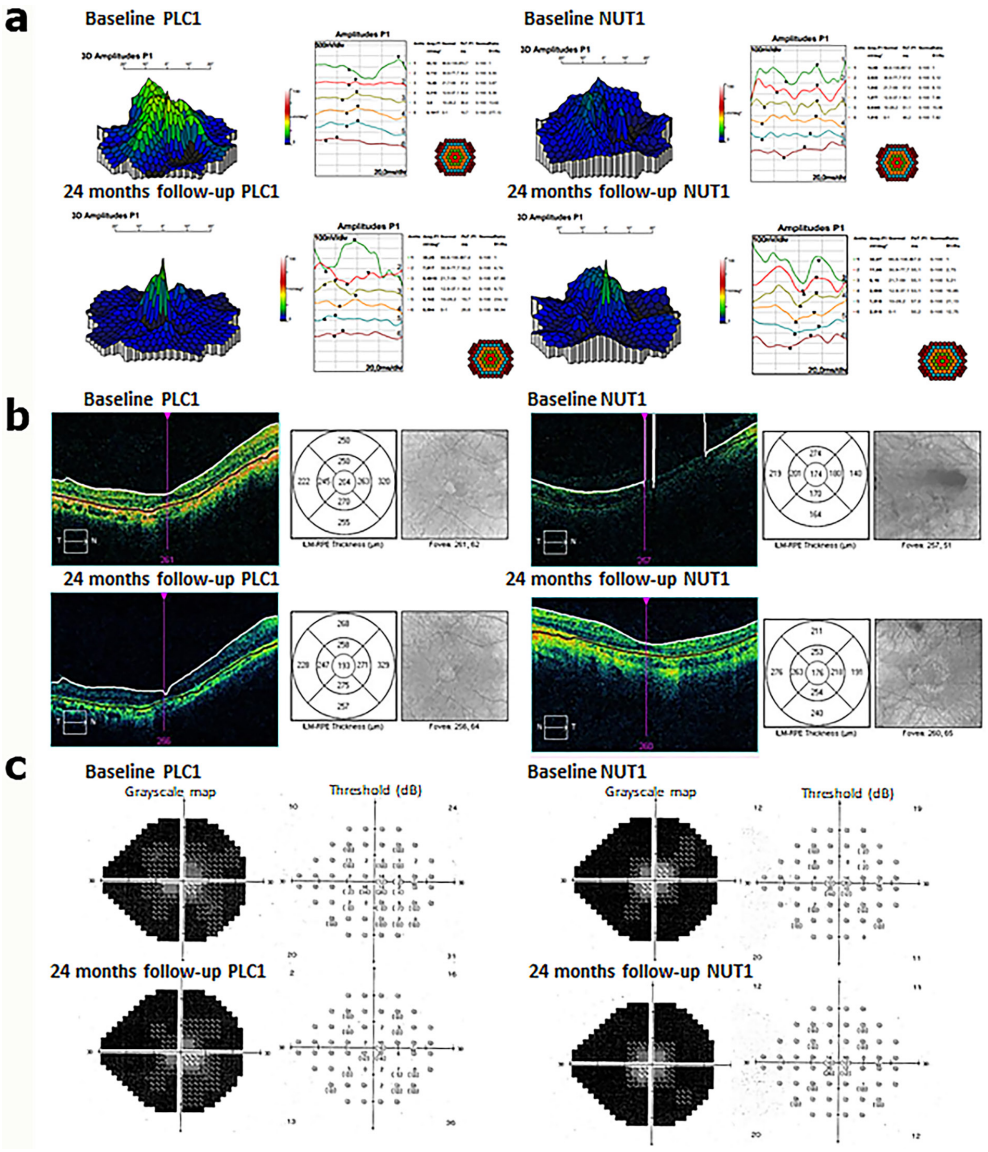

FIGURE 1. Ophthalmological tests conducted with both groups.

Experimental Methods: We carried out a randomized, double-blind, placebo-controlled study. Thirty-one patients with RP between the ages of 20 and 66 (mean: 51 ± 2, 16 males and 15 females) participated in the study. RP patients randomly received either a mixture of nutraceuticals (NUT) or a placebo daily for two years. At baseline and after two years of the nutritional supplementa-

tion, visual function, dietetic-nutritional evaluations, serum concentration of nutraceuticals, plasma and aqueous humour concentration of redox status and inflammation markers were assessed. Retinal function and structure were assessed by multifocal electroretinogram (mfERG), among others (Fig. 1). Nutritional status was estimated with validated questionnaires. Total antioxidant capacity, activity of antioxidant enzymes, protein carbonyl adducts (CAR) content, thiobarbituric acid reactive substances (TBARS) formation, nitrites and cytokine concentration were assessed in aqueous humour or/and blood. Bayesian inference was performed as a means of statistical analysis.

Results: At baseline, a high probability of an altered ocular redox status and to a lesser extent systemic redox status was observed in RP patients compared to controls. Twenty-five patients completed the nutritional intervention. After two years of supplementation, patients who received NUT presented better retinal responses (mfERG responses) than patients who received a placebo. Besides, patients who received NUT showed a better ocular antioxidant response (SOD3 activity) and lower oxidative damage (CAR) than those who received a placebo.

Discussion: Nutraceuticals are natural compounds with health benefits that can be used to prevent or treat human ocular diseases [1]. We assessed the effect of NUT supplementation on the progression of RP, an inherited retinal degeneration that leads to photoreceptor loss and eventually to blindness [2]. Our findings suggest that NUT improved ocular redox status and slowed down retinal degeneration observed in RP patients [3].

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1.7. SPECIAL POPULATIONS

Assessment of saccadic movements in Parkinson's disease patients using the King-Devick test

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Aim: To analyse horizontal saccadic movements in Parkinson's disease patients (PD) with the King-Devick (KD) test, comparing with the results of a control group (CS), to determine whether this test is useful in the early diagnosis of these patients.

Experimental method: 25 PD (70±9 years, 14 men, 11 women) and 21 CS (59±16 years, 8 men, 13 women) were included in a descriptive, observational, prospective, cross-sectional study. Subjects with binocular visual acuity (bVA) with an offset of less than or equal to 0.4 decimal at 3 metres, ocular problems, both binocular and oculomotor, diseases or other variables affecting vision or test performance, such as reading problems, were excluded.

All subjects were subjected to anamnesis, cover test, ocular motility in all gaze positions, bVA with compensation and the KD test at the Parkinson's centre to which they belong.

The data analysed were bVA with compensation, execution times and errors (partial and total) in the KD test and whether the subjects associated head movement during the test. It was tested whether age and gender influence the results.

Mean, standard deviations and normality of the samples were performed with the Shapiro-Wilk test. Statistical comparison between groups was performed with Student's t-test if the data followed a normal distribution or with

the Mann-Whitney U test otherwise. The statistical test used for qualitative variables was Pearson's chi-squared test.

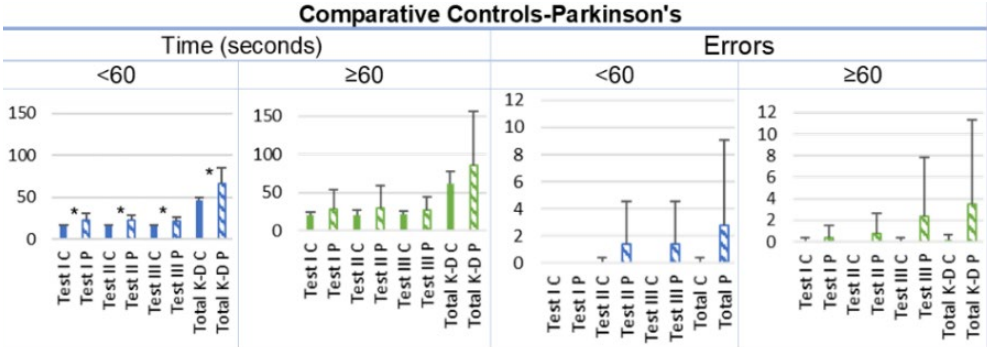

FIGURE 1. Comparison of times and errors made in the K-D test between CS (plain) and PD (striped) younger (blue) and older (green) than 60 years of age. The sign '*' means that p-value <0.05.

Results: One EP subject over 60 years of age was excluded because he was unable to perform the K-D test.

In both populations, PD and CS, a dependence of the KD test performance time on age was found (p=0.003 and p=0.004); the older the age, the longer the KD test running time. Test performance was not gender-dependent (p=0.354 and p=0.405) [1].

VA was 23% lower on average in PD, but the difference was only significant at older ages (p=0.004 for those over 60 (19PD, 10CS; under 60: 5PD, 11CS) [2].

Performance time was 52% longer in PD vs. CS (81±64 seconds vs. 53±14 seconds, p=0.005), though from the age of 60 years onwards the differences were not significant due to age-related slowing (Fig. 1) [3].

Although there was a tendency for PD to make more errors than CS (3% vs. 0%), the difference was not statistically significant (p=0.194). Furthermore, they tend to associate greater head movement (25% vs. 10%), but no significant differences were found (p=0.176).

Discussion: PD under 60 have longer KD test run times. Assuming that the older the patient, the greater the progression of the disease and the greater the degree of involvement, we can assume that patients under 60 had early stages of the disease. Therefore, the test could be a simple and quick tool to quantify ocular motility in early diagnosis of the disease. However, it would be necessary to carry out studies that separate by level of involvement to confirm this, as well as studies with a larger sample size in each group (under and over 60).

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Retinal vascular tortuosity in glaucoma and diabetic retinopathy: correlation with vessel diameters

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Aim: Examination of the retinal vasculature provides us with much information about the relationship between vascular morphological changes and various systemic diseases that affect the eye and other systems and organs of the human body [1]. Several parameters are included in the changes suffered by the retinal vessels, such as the change in vascular caliber and the tortuosity of the vessels, among others [2]. Our objective is to study the diameters of the retinal blood vessels and their tortuosity, normally not measured, and to establish relationships between the findings in pathological retinas.

Experimental method: In this study, 45 retinas classified as healthy retinas, diabetic retinopathy (DR) and glaucoma (15 images in each group) were analyzed. Using the ARIA algorithm described in [3], the diameters of the retinal vessels were calculated. A MATLAB software program was developed to process these da-

ta and obtain the diameters of each detected vessel and calculate its tortuosity [4]. The joint probability distribution of the diameters and tortuosity were then calculated and their correlations between the different groups were analyzed (Pearson correlation R). All the images come from the same database captured with the same retinograph using a Canon CF-60 UVi mydriatic fundus camera [5]. The degree of pathology for each retina was quantified from previous authors' studies on the same images, based on vasculature complexity [6].

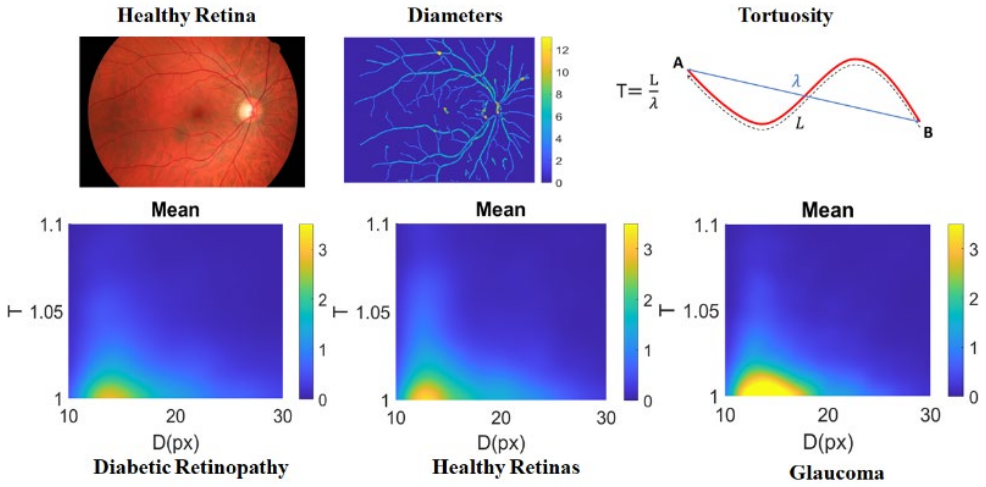

FIGURE 1. Mean probability distributions of the diameters and tortuosity.

Results: The joint probability density of diameters and tortuosity changes appreciably between healthy and glaucoma retinas, showing a decrease in both mean diameter and tortuosity for glaucoma. The changes are less appreciable for DR (see Figure 1), except in advanced stages. The control group only shows a significant ($p<0.05$) positive correlation for 13% of the cases ($R = 0.20$; $p = 0.0235$), increasing to 26% in DR ($R = 0.32$; $p = 0.0012$) and 40% in the case of glaucoma ($R = 0.22$; $p = 0.0183$).

Discussion: It has been shown that there is no great correlation between the diameters of the vessels and tortuosity in healthy retinas, while in the case of pathological retinas such as retinas with DR, it has been observed that as the pathology progresses (moderate-severe NPDR: non-proliferative Diabetic Retinopathy), a positive correlation appears between diameters and tortuosity. In the case of glaucoma, the diameters of the vessels decrease and become less tortuous, thereby establishing a positive correlation between both, more clearly visible. Tortuosity thus appears as an indicator of worsening pathology, appearing more commonly in the case of glaucoma. A possible factor that could affect the conclu-

sions is the duration of the disease when comparing the previous correlations between groups.

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1.8. VISUAL PERCEPTION AND PROCESSING

Analysis of the relationship between subjective measures of the visual function and ocular optical quality parameters in healthy patients

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Aim: The relationship between subjective measures of the visual function and objective parameters for characterizing the performance of the ocular optical system has been investigated for many years, confirming the variability and complexity of this issue [1]. The aim of this work was to study the correlation of objective aberrometric parameters with distance and near visual acuity and contrast sensitivity function.

Experimental method: A prospective cross-sectional non-comparative study was carried out at the Optometric Clinic of the University of Alicante. A total of 68 healthy subjects between the ages of 18 and 60 with no previous ocular pathologies or surgeries were included. All subjects underwent a complete optometric exam, including measurement of uncorrected and corrected distance and near visual acuities, subjective refraction, measurement of distance (CSV1000) and near (Optopad) contrast sensitivity function, as well as the measurement of various ocular variables, including pupillometry and ocular aberrometry, with the VX120 multidiagnostic system (Visionix, Chartres, France). The normality of all the data distributions obtained were first investigated using the Kolmogorov-Smirnov test. The correlation between objective and subjective variables was analysed using Pearson's correlation coefficient if the samples were normally distributed, and Spearman's coefficient otherwise. A value of $p<0.05$ was considered representative of statistical significance.

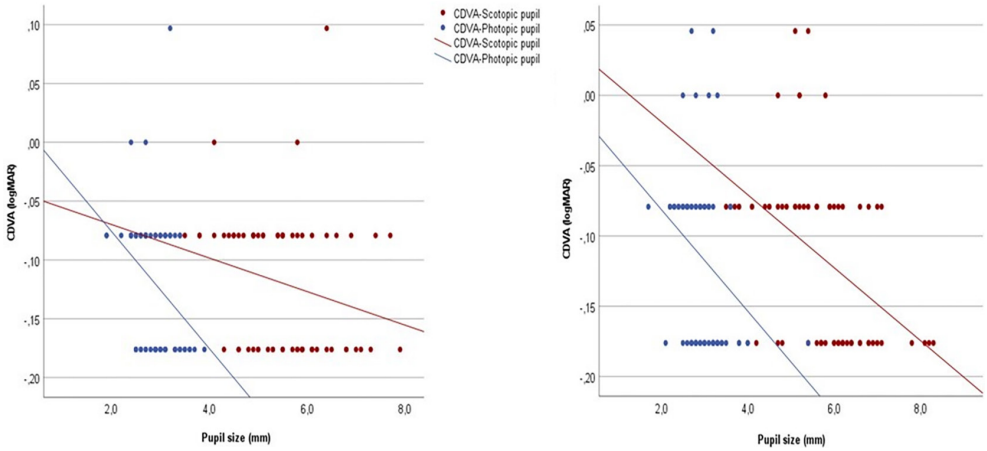

FIGURE 1. Correlation between CDVA and pupil size in photopic and scotopic conditions. On the left for the right eye and on the right for the left eye.

Results: In the sample analysed, the mean value of the refractive sphere for right and left eyes was –0.77±2.48 D (-7.75 to 5.25 D) and –0.55±2.43 D (-6.00 to 5.25 D), respectively. For the refractive cylinder, the mean values were –0.61±0.82 D (-4.25 to 0.00 D) and –0.62±0.73 D (-3.00 to 0.00 D), respectively. Statistically significant correlations of corrected distance visual acuity (CDVA) with the following variables were found, though limited in magnitude: distance contrast sensitivity (DCS) for 12 cycles/º (r=-0.345, p=0.004) and 18 cycles/º (r=-0.393, p<0.001), and scotopic (r=-0.368, p=0.002), mesopic (r=-0.374, p=0.002) and photopic pupil sizes (r=-0.391, p<0.001) for the right eye sample and CDVA with: DCS for 18cycles/º (r=-0.409, p=0.001), scotopic (r=-0.518, p<0.001), mesopic (r=-0.422, p<0.001) and photopic pupil diameters (r=-0.358, p=0.003) for the left eye sample. No significant correlations were detected between higher order aberrometric parameters and measures of visual function for the right eye sample (p>0.05), except for the correlation between ocular trefoil root mean square (RMS) (5 mm) and DCS for 18 cycles/º (r=-0.296, p=0.015) for the right eye sample and the correlation between trefoil RMS (5 mm) and near contrast sensitivity (NCS) for 1.5 cycles/º (r=-0.296, p=0.015) for the left eye sample.

Discussion: According to the results obtained, there is no obvious relationship between the subjective parameters for measuring visual function and higher order aberrometric parameters in patients with healthy eyes and without surgery [2]. On the other hand, there is some level of correlation between subjective measures of visual function and pupil size. It should be considered that the system used for measuring pupil size performs the measurement first in the left eye,

inducing a miosis, prior to the measurement of the right eye. This condition may have affected the results obtained (Figure 1).

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Perceptual scores of image quality at far distance through simulated bifocal corrections: addition and energy balance implications

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Aim: The main aim of this article is to study the effect of different amounts of addition and the energy balance between far and near vision of simulated bifocal corrections on perceived image quality at far vision reported by non-presbyopic observers with their refraction corrected.

Experimental method: Using a scaling psychophysical procedure, seven non-presbyopic subjects judged the perceived image quality through 15 bifocal corrections: five different amounts of addition (0.25, 0.50, 0.75, 1.50 and 3.00D), each with three energy balance distributions between far (F) and near (N) vision (70F/30N, 50F/50N and 30F/70N). Six monofocal corrections (0.00, 0.25, 0.50, 0.75, 1.50 and 3.00D) were also evaluated. All the corrections were simulated monocularly using SimVis Gekko (2EyesVision SL) [1], a programmable see-through visual simulator, while the subject viewed a 4K-60Hz natural color video sequence of walking people displayed on a TV screen four metres away, with an angular subtense of 13.09º x 7.45º. At the beginning of the measurement session, observers were shown the Sharp (0.00D) and fully Blur (3.00D) conditions, corresponding to the 10 and 0 extremes, respectively, on a Perceptual Score (PS) scale. Each trial started with an initial adaptation state of 3.00D Blur lasting 10 seconds followed by the abrupt introduction of a correction (bifocal/monofocal). Observers adapted for six seconds to the simulated correction and had a further two seconds to score the perceived image quality using the PS scale. Each condition (adaptation + bifocal/monofocal correction transition) was repeated three times in a randomized order. The average score was used to obtain the near bifocal perceptual benefit and the far bifocal perceptual cost for each correction. The near bifocal perceptual benefit was calculated as the difference between the near PS for each correction and the corresponding monofocal correction for the same addition, while the far bifocal perceptual cost was obtained by subtracting the far PS for each correction from 10.

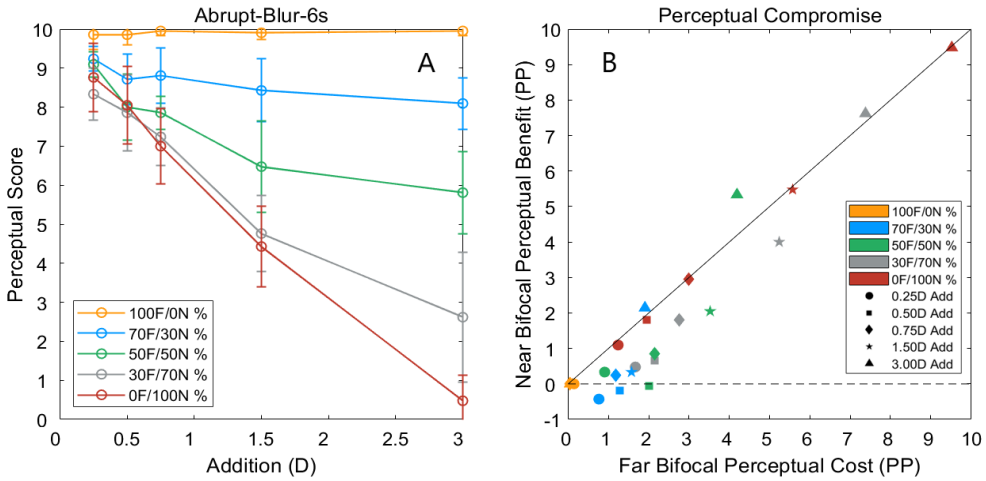

FIGURE 1. **A)** Perceptual Scores through simulated corrections with different amount of addition and energy balance: average across subjects and standard deviation. **B)** Perceptual compromise for each correction evaluated: near bifocal perceptual benefit vs far bifocal perceptual cost.

Results: Perceptual judgements revealed that PS decreases as the percentage of energy at near vision and the amount of addition increases (Fig.1A). PS drops linearly from 10 to 0.48 for pure defocus monofocal corrections (ρ=-0.99; p-value<0.01). Similarly, corrections with 3.00D of addition also showed a linear behavior for different energy distributions between far and near vision (ρ=0.98; p-value<0.01). However, for bifocal corrections with equal energy balance between far and near vision, the PS are sustained as the addition increases, ending up, for 3.00D of addition, at 8.10 (SD: ± 0.66) Perceptual Points (PP) for 70F/30N (ρ=-0.91; p-value<0.05), 5.81 ± 1.05 PP for 50F/50N (ρ=-0.92; p-value<0.05) and 2.62 ± 1.66 PP for 30F/70N (ρ=-0.98; p-value<0.01). Finally, the perceptual compromise (Fig.1B) showed a linear dependence between the bifocal perceptual benefit and cost for most of the corrections evaluated (ρ=0.96; p-value<0.01).

Discussion: Perceived image quality through different simulated corrections exhibited a linear degradation for pure defocus produced by monofocal lenses. In contrast, bifocal corrections showed stronger perceptual degradation for small addition values up to 0.75D and increased resistance to such degradation for higher addition values, according to their far/near energy distribution. This can be explained by the interactions between the focused peak (far vision) and the background (near vision) of the PSF, already reported by Radhakrishnan et al [2], generating a greater degradation when the defocus between them is smaller, corresponding to low additions.

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Visual system and visuomotor skills: review and study proposal

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Aim: To study the relationship between contrast sensitivity function (monocular and binocular) and the performance of fine motor skills through a manual dexterity test.

Experimental method: First, a review of the literature was carried out through the "Web of Science" (WOS) database using the keywords: "visuomotor skills", "binocular vision" and "fine motor skills". The aim was to determine the visual parameters that have been analyzed in previous studies in terms of the relationship between binocular visual function (stereopsis, binocular summation, optical or visual quality, vergences and accommodation) and the execution of tasks involving fine motor skills (execution time, precision and dexterity in the performance of certain manual dexterity tests). Then, an experiment was carried out including nine participants with normal binocular vision and binocular visual acuity (VA) greater than or equal to one. Directional ocular dominance was determined. Contrast sensitivity (CS) was measured using an OptoTab® test (SmarThings4Vision), which comprises sinusoidal grids for which the observers had to recognize and indicate whether the grid inclination was to the right, the left or vertical. Different contrast sensitivity levels were assessed in this test, at five different spatial frequencies: 1.5, 3, 6, 12 and 18 cycles per degree (cpd) of visual angle. To assess fine motor skills, a Purdue Pegboard test was performed, using both hands simultaneously under three viewing conditions: dominant eye, non-dominant eye and binocular.

Results: Regarding the 17 selected articles, the experiments had been carried out with children and, to a lesser extent, with adults. Generally, it was reported that the absence of binocular vision had a negative effect on reaching and picking up objects, since, under monocular conditions, times increase, and a greater number of errors appear in executing the task [1-3]. One of the most recent studies found that a higher maximum reach speed was associated with better

vergence function. Lower stereoacuity thresholds were associated with shorter grasp duration and better accommodative function was associated with shorter placement duration [2]. The visual function parameters measured in these experimental studies were analyzed. However, in this analysis, no studies were found that looked at contrast sensitivity function and at performing tasks requiring fine motor skills. We have found little consensus related to the tasks performed. Therefore, we carried out our experimental study and obtained a significantly positive correlation between the near CSF and the number of pegs inserted in the Purdue Pegboard test in the three observation conditions [r= 0.778 p= 0.001] (Figure 1).

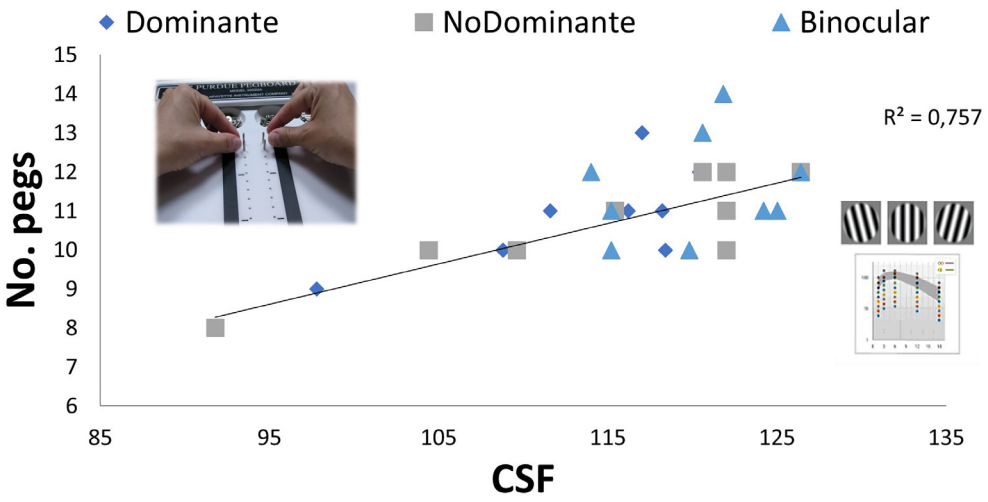

FIGURE 1. Correlation between CSF and Purdue Pegboard task.

Discussion: According to the studies analyzed, we concluded that visual functions (stereopsis, vergences and accommodation) are related to fine motor skills, though the relationship between them is still under investigation. By proposing an analysis of the relationship and involvement of other visual function characteristics (specifically CSF) in a standardized task that involves fine motor skills (Purdue Pegboard test), a statistically significant positive relationship has been obtained. In other words, better CS values have been related to improved task performance.

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1.9. OTHER OPTOMETRY-RELATED TOPICS

Assessment of reading speed and visual fatigue with different types of controlled lighting

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Aim: To assess reading speed and objective visual discomfort through the use of the eye-tracker and the aberrometer in distinct ambient lighting conditions and luminances of two different types of electronic screens.

Experimental method: This study was carried out on 24 young subjects, with a mean age of 22.9±2.3 years (18-33) and a mean spherical equivalent refractive error of –0.75±1.50 D, who read for 5 minutes on an e-book and on an iPad in maximum and minimum lighting conditions, while being monitored with an eye-tracker. The evaluated conditions included high ambient illuminance level (945.65 lx) with maximum luminance on the iPad (Imax) and e-book reader (Emax) [484.01 cd/m2 and 79.60 cd/m2]; and low ambient illuminance level (4.38 lux) with minimum luminance on the iPad (Imin) and the e-book reader (Emin) [1.56 cd/m2 and 0.14 cd/m2]. Aberrometry was performed before and after each reading; after performing the task, subjects were asked to answer a question about visual comfort. Aberrometry was used to find the evaluated situations in which there was greater discomfort and see if the five minutes of reading were enough for that fatigue to appear visual. Measurements of pupil diameter, fixations, saccades and blinks were taken by the eye-tracker, as well as values of total, high order and low order aberrations by the aberrometer. A statistical analysis was performed of the data obtained. The measurements were entered in a Microsoft Office Excel spreadsheet and were analyzed with the Statistical Package for Social Sciences.

Results: Eye-tracker data revealed a higher number of saccadic eye movements with statistically significant differences ($p<0.05$) under minimum and maximum luminances; for the iPad under minimum luminance 841.30±799.61 movements and under maximum luminance 999.18±282.54 movements ($p=0.016$), and for the e-book reader under minimum luminance 610.85±320.72 movements and under maximum luminance 940.26±218.18 movements ($p=0.002$). In addition, the length of saccades was also higher for the lower luminance level; these values were 6.2±2.8 mm (Emax), 8.2±4.2 mm (Emin), 6.8±2.9 mm (Imax) and 7.6±3.6 mm (Imin). The pupil diameter and the blinking rate increased significantly for lower lighting conditions for both devices. The pupil diameter for the iPad under minimum luminance was 5.52±0.79 mm and under maximum luminance was 2.74±0.35 mm, and for the e-book reader under minimum luminance was 5.46±0.74 mm and under maximum luminance was 2.86±0.43 mm. Additionally, aberrometric analysis indicated differences in high-order aberrations between post-reading situations, although the differences were not statistically significant compared to the initial state, showing visual recovery of the ocular system. The two devices presented greater visual discomfort when reading in conditions of both low luminance and ambient illuminance. This was measured through a questionnaire completed by the participants.

Discussion: Reading speed and visual discomfort caused by using electronic screens can be objectively evaluated with an eye-tracker and aberrometer. Lighting control is essential to minimizing those aspects and promoting subjective visual comfort while reading. [1-9].

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Influence of author's gender on peer-review timing in vision science publications

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Aim: When analysing the causes of female underrepresentation in science, it has been suggested that "society is trying to solve problems of the past that are no longer currently valid".[1] However, recent evidence seems to prove otherwise. Thus, our purpose was to investigate if a gender gap exists in first/last authorships in vision science publications and whether author's gender plays a role in manuscript review times. In the end, whilst female ophthalmologists and first author female (FAF) publications grew in parallel from 1960 to 2009, last author

female (LAF) publications increased more slowly and, a decade later, articles with female key authors are less cited than their male counterparts [2, 3]. Moreover, men win a greater proportion of awards [4] and women are given fewer opportunities to gain surgical competence during ophthalmological training. [5].

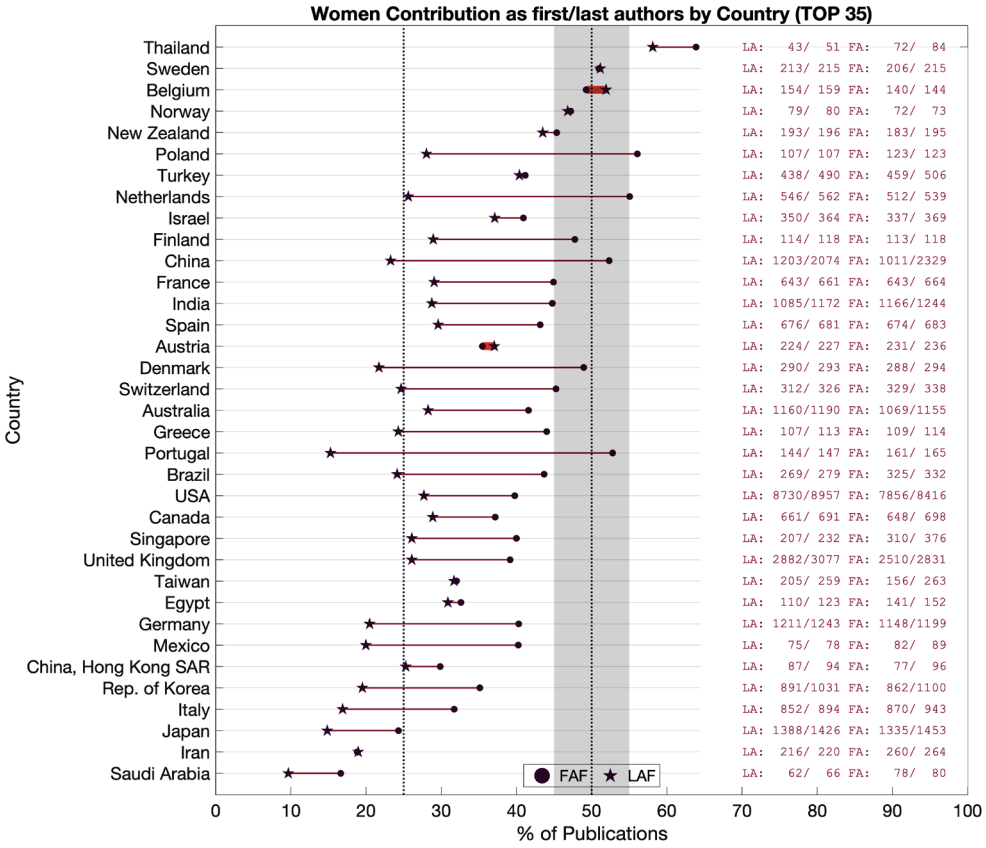

FIGURE 1. Female contributions as first/last author per country.

Experimental method: We conducted an observational retrospective database study. The data were derived from Q1-Q2 'Ophthalmology' journals for 2016-2020. First/last author's gender and country were assigned to PubMed records (N=30438). Using mixed models that considered the publication origin as a confounding factor, the influence of FAF and LAF were evaluated on the manuscripts' review timeline. This analysis was performed globally and in predefined subgroups (English names, Asian names, specific topics). Additionally, the gender gap was explored by country, journal and research topic.

Results: The percentages of FAF/LAF were unevenly distributed by country, with only four countries having reached parity in both first and last authorships (Figure 1). In the top 30 ophthalmology journals, FAF accounted for 40.0±6.7% of the publications while LAF accounted for 27.1±4.9%.

Overall, FAF/LAF papers took significantly longer to get reviewed (up to +10 days) and accepted (+5 days). These differences persisted when only publications from authors with English names – easily recognizable worldwide – were considered, but not for Asian names. Delays >1 month to get a manuscript published were found for FAF in three of four topics analyzed (e.g., amblyopia or refractive surgery).

Discussion: Significant differences were found in both review and acceptance times for FAF or LAF papers. The causes for this are likely multifactorial and could be explained by a combination of gender bias and by women's concerns with being held to higher standards, as previously documented, thereby perhaps delaying reviewers' rebuttals. Increased awareness of this source of potential bias may assist in the implementation of preventive and corrective measures.

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POSTER COMMUNICATIONS

2.1. ANTERIOR SEGMENT

Effect on quality of life associated with the state of the ocular surface due to mask use

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Aim: The aim of this study was to evaluate the symptomatology compatible with dry eye in patients who wear a mask, Mask-Associated Dry Eye Syndrome (MADE syndrome), by comparing the subjective measured variables (questionnaires) and objective variables (ocular surface parameters) among patients without a mask, patients with a mask and patients with a mask and cataract surgery. It was also decided to study some psychological symptoms in patients who wear masks and compare them with patients who do not use masks.

Experimental method: All subjects were men and women over the age of 18. All subjects with pathologies with ophthalmic repercussion, with some alteration of the ocular surface or with topical eye treatment other than artificial tears were excluded. The population was divided into three groups:

- Healthy group without mask (64 subjects): patients in this group were removed from a previous study done in 2018. Patients associated with any kind of eye surgery were excluded.
- Group with mask without surgery (58 subjects): The patient must have worn the mask for at least three hours per day during the two weeks preceding the data collection and for one hour prior to the examination. Patients associated with any kind of eye surgery were excluded.
- Group with mask having had cataract surgery a month before (36 subjects): The patient must have worn the mask for at least three hours per

day for two weeks preceding the data collection and for one hour prior to the examination. Patients associated with eye surgery other than cataracts were excluded.

The tests performed can be divided into two parts depending on whether they study the symptoms perceived by each patient or the signs presented. To begin with, all patients were asked three demographic questions, followed by three questionnaires to carry out the symptomatic study (CLDEQ-8 test adapted to the use of a mask, OSDI and SANDE) and a questionnaire to evaluate the psychological state of the individuals (BSI test) (see Table 1).

Finally, to achieve a more objective study, typical signs of dry eye disease such as tear meniscus height or NIBUT were evaluated with a Keratograhp 5M.

	Healthy			Mask			
Parameter	Min	Max	X ± SD	Min	Max	X ± SD	p-value
Sande [mm]	1	25,00	7,09 ± 6,42	0	88,50	22,04 ± 23,48	<0,01
Meniscus [mm]	0,14	0,57	0,27 ± 0,10	0,13	1,13	0,35 ± 0,17	<0,01
NIBUT [s]	3,31	24,92	17,05 ± 6,74	3,57	25,05	18,64 ± 7,50	<0,05
Redness	0,30	2,00	0,82 ± 0,38	0,10	1,60	0,83 ± 0,42	0,76
Depresion [%]	0	29,20	6,58 ± 7,91	0	91,70	21,68 ± 22,21	<0,01
	Mask			Mask + Surgery			
Parameter	Min	Max	X ± SD	Min	Max	X ± SD	p-value
Sande [mm]	0	88,50	17,54 ± 22,56	0	57,45	17,02 ± 16,25	0,60
Meniscus [mm]	0,13	1,13	0,39 ± 0,18	0,17	1,46	0,48 ± 0,28	0,28
NIBUT [s]	3,57	25,05	16,51 ± 8,23	1,15	25,02	16,51 ± 8,23	0,86
Redness	0,20	2,50	1,08 ± 0,46	0,50	2,50	1,27 ± 0,51	0,10
Depresion [%]	0	45,80	12,94 ± 12,87	0	45,80	12,50 ± 13,48	0,76
	Healthy			Mask + Surgery			
Parameter	Min	Max	X ± SD	Min	Max	X ± SD	p-value
Sande [mm]	1	25	7,09 ± 6,42	0	57,45	17,58 ± 17,09	<0,05
Meniscus[mm]	0,14	0,57	0,27 ± 0,10	0,22	1,18	0,46 ± 0,24	<0,01
NIBUT [s]	3,31	24,92	17,05 ± 6,74	2,55	25,02	18,08 ± 8,54	0,29
Redness	0,30	2,00	0,82 ± 0,38	0,50	2,50	1,20 ± 0,51	<0,01
Depresion [%]	0	29,20	6,58 ± 7,91	0	45,80	13,58 ± 14,54	0,10

TABLE 1. Study results. Min: minimum; Max: maximum; X SD: mean and standard deviation; P-value: results of p-value; Sande: results of SANDE test; Meniscus: meniscus height; NIBUT: Non-Invasive Break Up Time; Redness: ocular redness; Depression: rate of depression.

Results: Statistically significant differences were observed in the SANDE test (p-value<0.01), in the height of the lacrimal meniscus (p-value<0.01) and in the NIBUT (p-value<0.05) when comparing the group of healthy individuals with the group of mask-wearers without cataract surgery. An increase in the rate of depression (p-value<0.01) was also observed in the group of mask wearers compared to that of non-wearers.

When comparing the group of healthy individuals with the group of mask-wearers with cataract surgery, significant differences were obtained (p-value<0.01) in the SANDE test, in the tear meniscus height and in ocular redness.

No statistically significant results were observed when comparing both groups of mask-wearers.

Discussion: The symptomatological tests suggest that the use of masks has increased symptoms similar to those observed in dry eye disease respect to the non-use of masks, confirming MADE syndrome. The same was found in a study conducted through the software program Google Forms (Borcardo L, 2022).

On the other hand, objective tests show an increase in the height of the lacrimal meniscus and NIBUT in the group of mask-wearers, contrary to what is found in a study conducted in Madrid (Arriola-Villalobos P, 2021). However, this increase is not considered beneficial due to the presence of eye discomfort and ocular redness.

The increase in the rate of depression in the group of mask-wearers over that of non-wearers could be explained by the situation experienced throughout the confinement.

Changes in the corneal endothelium after cataract surgery

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Aim: This study analyzes changes in corneal thickness and the density and shape of endothelial cells in patients after undergoing cataract surgery.

Experimental method: Corneal central thickness, cell density and the percentage of cells with a different number of sides before and after surgery were analyzed with an endothelial microscope (Perseus, CSO, Florence, Italy) in 20 eyes belonging to 20 patients. Data was obtained from the Aiken Ophthamological Clinic database. Normality tests were performed with the Shapiro-Wilk test. Statically significant differences between pre-surgical and post-surgical values

were assessed with a T-test for related samples (parametric statistics) and the Wilcoxon signed-ranks test (non-parametric statistics).

			Mean ± SD	Median	Maximum	Minimum	*Shapiro-Wilk*	*p-value*
Corneal thickness (µm)		Pre	550±40	558,50	469,00	628,00	0,819	0,335
		Post	550±40	548,50	464,00	631,00	0,996	
Numbers of cells		Pre	2400±300	2395,00	1994,00	2913,00	0,506	<0,001*
		Post	2100±400	2055,00	1342,00	2731,00	0,773	
% of cells	4	Pre	1,1±0,8	1,00	0,00	3,00	0,007	0,150
		Post	0,60±0,9	0,00	0,00	3,00	<0,001	
	5	Pre	25±4	26,00	18,00	34,00	0,735	0,006*
		Post	23±4	23,00	15,00	28,00	0,193	
	6	Pre	54±7	54,50	40,00	65,00	0,512	0,022*
		Post	58±6	58,00	49,00	71,00	0,558	
	7	Pre	18±3	17,00	12,00	23,00	0,394	0,322
		Post	17±3	17,00	12,00	21,00	0,400	
	8	Pre	1,8±1,5	2,00	0,00	6,00	0,003	0,524
		Post	2,0±1,5	2,00	0,00	6,00	0,016	
	> 8	Pre	0,2±0,5	0,00	0,00	2,00	<0,001	1,00
		Post	0,2±0,4	0,00	0,00	1,00	<0,001	

*The numbers 4,5,6,7 and 8 represent the number of sides of the cells

FIGURE 1. Corneal endothelium parameters before and after cataract surgery.

Results: Table 1 shows the results obtained. There were no changes in corneal thickness after the intervention. A significant decrease in endothelial cell density and variations in cell morphology have been observed.

Discussion: Results obtained from this analysis in terms of corneal thickness and cell density are consistent with the published literature, which indicates that in healthy adults the corneal thickness is 540 µm and normal values of the cell density is 2400 cells/mm [1-3]. However, data from pleomorphism are in disagreement with current scientific evidence, which shows that the percentage of hexagonal cells decreases (pleomorphism) and increases the coefficient of variation of cell size [4]. This discrepancy may be due to the small number of patients in the sample.

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Corneal manifestations in systemic diseases: a case report

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Aim: To spotlight the importance of gaining a careful anamnesis and performing an eye examination because ocular manifestations could be the first sign in systemic collagen vascular diseases [1].

Experimental method: A 26-year-old man came to the ophthalmology clinic with painless superior corneal melting in his left eye. He referred to a foreign body associated with eye watering that had started eight days before. In the emergency room, he was diagnosed with corneal perforation, which was treated with contact lens. When the patient arrived at our service, he did not present corneal perforation, though he did present severe stromal melting [2].

He had no previous systemic or ocular diseases but a positive family history of rheumatoid arthritis.

The optometric evaluation indicated spontaneous visual acuity (VA) of 20/50 and best corrected VA of 20/25 with 125° –5.0 cyl; +1.0 sph. and an intraocular pressure (IOP) of 11mmHg in the damaged eye.

We also did an eye exam with slit lamp and an anterior segment optical coherence tomography (AS-OCT) (Figures 1 and 2).

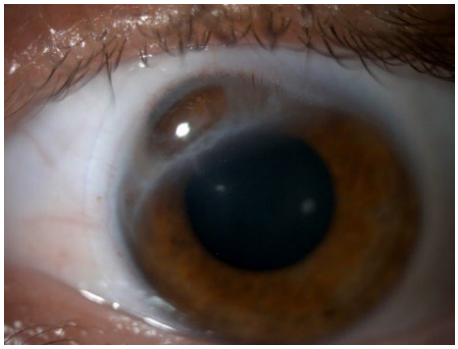

FIGURE 1. Corneal picture of the left eye gets with slit lamp (Topcon).

FIGURE 2. Corneal section of the left eye gets with AS (Casia).

Results: The AS-OCT highlighted corneal melting compatible with some clinical entities, such as Terrien's marginal degeneration, Mooren's ulcer or peripheral ulcerative keratitis (PUK). PUK is a rare but serious inflammatory condition that affects the juxtalimbal cornea and is characterized by sectorial thinning of the affected area. The treatment usually consists of a combination of topical steroids, antibiotics and surgical therapy with conjunctival flap to promote healing [3].

Discussion: Systemic diseases affecting the cornea have a wide range of manifestations. In some cases, it may be the first sign of the disease. PUK presents with epithelial defect and stromal lysis. The underlying cause could be local or systemic, infectious or noninfectious.

The most serious ocular complication is a corneal perforation that results in a poor visual outcome despite treatment. It is also associated with a 50% risk of mortality over a 10-year period in untreated patients. [4] The etiology of PUK must undergo a detailed personal and family history to reveal underlying colla-

gen vascular disease and other autoimmune diseases. Symptoms, signs, biomarkers and other examinations are an important part of the differential diagnosis, which is crucial to reducing mortality and systemic and ocular morbidities.

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Effects of computer use on blinking kinematics

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Aim: This study aims to assess and compare the differences in blinking kinematics while reading on a computer with and without artificial tear instillation and a non-device control condition.

Experimental method: Thirty-two healthy subjects (12 men and 20 women) between 20 and 26 years old (22.5 ± 1.6 years old) participated in this prospective clinical study. Participants' blinking was recorded while reading on a com-

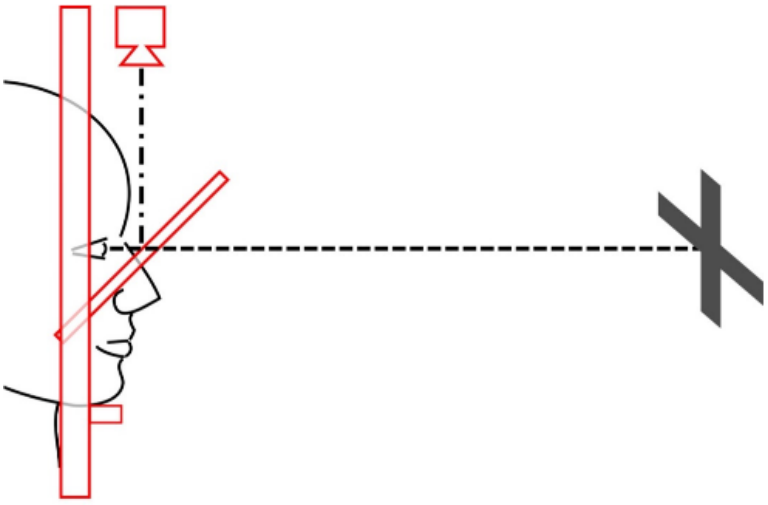

FIGURE 1. Diagram representing the configuration of the high-speed visual eye-tracker.

puter placed 60 cm in front of them, under normal conditions and after initial instillation of artificial tears (Aquamax®, Tiedra SL, Alcorcón-Madrid) and during a non-device control condition in which participants directed their gaze at a fixed target located three meters in front of them at eye level. The computer used in the study was a MacBook Pro laptop (Apple Inc., Cupertino, CA) with a 13-inch screen, a resolution of 227 pixels per inch, a refresh rate of 60 Hz and a contrast ratio of 1350:1. The text displayed was Georgia font with black letters on a white background (left-justified) with an angular size for 0.15 logMAR visual acuity and an angular page width of 25°. Blinks were recorded during the last 150 seconds of the task (minutes 12.5 to 15), without the subjects being aware of it, using an eye tracking device (Cambridge Research Systems Ltd) based on a high-speed infrared camera (250 fps). Due to the configuration of the device, the image of the eye was reflected on an infrared mirror without interfering with the observer's line of sight, simulating natural viewing conditions (Figure 1). Image files were automatically analyzed using a set of self-developed tools for Matlab R2018a (Mathworks, Natick MA, USA) to obtain a detailed and non-invasive description of the blinking pattern. The results were evaluated using SPSS software v.26 (IBM Corp., Armonk, NY). The normality of data was assessed by using the Shapiro-Wilk test. When normality could be assumed, a repeated measures ANOVA was used to examine the statistical significance of the blink kinematic variables for the three task conditions. Mauchly's test was used to evaluate the assumption of sphericity. If sphericity could not be assumed, the Greenhouse-Geisser correction was applied. Whenever the repeated

measures ANOVA pointed to a statistical significance, post-hoc pairwise comparisons were carried out using the Bonferroni correction. The non-parametric Friedman test for repeated measures with Dunn-Bonferroni post-hoc analysis was used when parametric test assumptions were not fulfilled. P-values of < 0.05 were considered statistically significant.

Results: Blink frequency (total number of blinks in one minute) significantly decreased during computer reading with (mean = 10.7 blinks/min) and without the instillation of artificial tears (mean = 9.8 blinks/min) compared to the control condition (mean = 20.4 blinks/min) ($p < 0.01$). Conversely, the percentage of incomplete blinks increased significantly during computer use (mean = 53.9%), compared to the control condition (mean = 38.9%) ($p = 0.02$), but not when using the device after the instillation of artificial tears (mean = 47.4%) ($p = 0.08$). Blink opening and closing amplitudes were significantly lower during computer use (mean = 4.3 mm) regardless of artificial tear instillation (mean = 4.3 mm) compared to the control measure (mean = 5.4 mm) ($p < 0.01$ for both). On the contrary, the closing time was significantly longer when reading on the computer after the instillation of artificial tears (mean = 50.3 ms) compared to conventional reading (mean = 38.9 ms) and the control condition (mean = 41.6 ms) ($p < 0.01$ and $p = 0.01$, respectively), while the opening time did not vary significantly between conditions (mean = 185.0 ms for control, mean = 158.8 ms for computer and mean = 162.0 ms for computer and artificial tears) ($p = 0.07$). Finally, a lower closing speed was obtained when reading on the computer after artificial tear instillation (mean = 103.6 mm/s) compared to the remaining conditions (mean = 141.2 mm/s for the control and mean = 118.6 mm/s for the computer) ($p < 0.01$ for the control and $p = 0.02$ for the computer without artificial tears), while opening speed remained unvaried (mean = 39.8 mm/s for control, mean = 37.5 mm/s for computer and mean = 34.8 mm/s for computer and artificial tears) ($p = 0.82$).

Discussion: Blinking kinematics varied considerably when using the computer, these differences being likely attributable to the way the device was positioned and the cognitive demand of the task. Artificial tear instillation prevented an increase in the percentage of incomplete blinks when using the computer, while leading to slower blink closure.

Face mask-associated ocular manifestations during the Covid-19 pandemic: a systematic review

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Aim: During the COVID-19 global pandemic, prolonged face mask use was one of the mains recommendations to prevent the infection. Thus, it would be interesting to systematically evaluate if there is a strong association between face mask use and ocular pathologies related to the eyelids and ocular surface.

Experimental method: The systematic review was designed and realized following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). In March 2022, we performed a systematic literature search among the electronic databases PubMed, Scopus and Web of Science. We included studies that 1) used the face mask as a measure to prevent the spread of COVID-19, 2) were conducted in humans, 3) were carried out during the COVID-19 pandemic (from January 2020 to March 2022) and 4) assessed ocular conditions. However, studies were excluded if 1) they included people under 18 years old, 2) assessed ocular manifestations not related to the eyelids or ocular surface, 3) were abstracts of books and conferences, or commentaries, letters to the editor and round table discussions, as well as duplicate publications or articles without full text, and 4) were not published in English, Spanish or French.

Results: The search identified a total of 15 studies according to the eligibility criteria of our systematic review. The studies included were three cross-sectional design studies, two cohort design studies, three case-control design studies, four case reports, two case series and one review article (Table 1).

First author	Year	Study design	Sample size	Sample characteristics	Results
Chadwick *et al.*	2020	Case report	1	66 years, female	Face mask increases the risk of dry eye in the post-operative.
Azzam *et al.*	2022	Cross-sectional	60	Group 1: n=30, 7 males, 23 females, 18-61 years Group 2: n=30, 17 males, 13 females, 18-64 years	N95 face masks produce more dry eye signs, although there aren't significative differences on the symptoms.
Ramani *et al.*	2021	Case series	3	(1): 28 years, female (2): 35 years, female (3): 30 years, female	Face masks should be used carefully to avoid ocular traumatisms.
Au *et al.*	2020	Case report	1	51 years, male	Face masks should be used carefully to avoid ocular traumatisms.
Mastropasqua *et al.*	2021	Cohort	128	Group 1 (dry eye): n=66, 40 males, 26 females, 40-58 years Group 2 (healthy): n=62, 35 males, 27 females, 37-53 years	The daily use of face masks damages the ocular surface, which is aggravated when dry eye is already present.
Silkiss *et al.*	2021	Case-control			Face masks increase the incidence of chalazion.
Martínez-Pérez *et al.*	2021	Case-control	177	49 males, 128 females, 27-49 years	The use of face masks increases the ocular symptoms in contact lenses users.
Nair *et al.*	2022	Case report	1	26 years, male	A bad fitting of face mask can produce ocular traumatisms and increase post-operative complications.
Krolo *et al.*	2021	Cohort	203	59 males, 144 females, 47.4 years	Having precedents of dry eye, being female and wearing face mask for more than 3 hours per day can worsen dry eye symptoms.
Marinova *et al.*	2020	Case-control	144	80 females, 64 males, 22-79 years	The use of face masks causes ocular discomfort even in healthy patients, and this depends on type of face mask and hours of use.
Scalinci *et al.*	2021	Cross-sectional	67	27 males, 40 females, 35-55 years	Prolonged face mask use is associated with increased OSDI scores.
Shubhanshu *et al.*	2021	Cross-sectional	423	320 males, 103 females, 21-47 years	Prolonged face mask use causes different symptoms as ocular dryness.
Koh *et al.*	2021	Review			The COVID-19 pandemic has led to a significant increase in DED and the need for developments and advances in screening.
Zhou *et al.*	2021	Case series	8	6 males, 2 females, 18-67 years	Face masks should be used carefully to avoid ocular traumatisms, and it should be reviewed their production specifications.
Tang *et al.*	2021	Case report	1	52 years, male	Face masks should be used carefully to avoid ocular traumatisms.

TABLE 1. Table with the characteristics of the included studies.

Discussion: Overall, face mask use was associated with an increased incidence of chalazion and ocular discomfort, even in healthy patients, related to mask type and hours of use. It was also associated with an increase in dry eye symptoms and signs and Ocular Surface Disease Index (OSDI) scores, worsening in patients already diagnosed with dry eye disease (DED) and in contact lenses (CL) users, as well as postoperatively. In addition, several cases of ocular trauma due to poor fit and incorrect use of the facemask were found [1, 2].

Even though the findings showed a higher incidence of ocular manifestations associated with prolonged use of the face mask, its use is a primary and effective measure to prevent the spread and infection of COVID-19. With the research that has been done to date, we believe that it would be advisable to be more cautious in the use of face masks and to increase the frequency of instillation of preservative-free ocular lubricants in order to reduce ocular symptoms and avoid possible complications.

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Influence of the use of digital screens on the tear film in frequent computer users

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Aim: The main purpose of this article is to know the effects that the use of digital computer screens can produce on the volume, quality and stability of the tear film for four hours.

Experimental method: An observational study was carried out on 29 healthy subjects who usually stayed between two to 10 hours a day in front of a VDT device to be included in the study. The study included people of both sexes between 18 and 55 years old. Those who presented symptomatic and/or diagnosed dry eye, who were contact lens users or who were under topical or systemic treatment with drugs that alter the production and stability of the tear film were excluded.

The patients were scheduled in the morning for the first measurement, in which the visual fatigue questionnaire was filled out, the OSDI test was performed and finally the measurement was made with the Keratograph. The patients then proceeded to perform their usual tasks on the computer for four hours in a work room. At the end of this period, the measurements were once again taken from the subjects; the OSDI questionnaire was not applied in the second measurement. The visual fatigue questionnaire consisted of questions about ocular symptoms such as burning, dryness, redness, asthenopia, stinging, headache and sensitivity to light. The subject was to rate their manifestation on a scale of 0 to 5.

Results: Nine of the participants were men and 20 women. When analyzing the symptomatology related to the visual fatigue questionnaire, the symptoms that increased in greater proportion in the second measurement were dryness of the eye and visual asthenopia. The objective measurements of tear film lipid properties of each eye had a statistically significant variation with respect to the four hours of use, as did the measure of ocular redness.

Variable	Baseline (0 hours)	4 hours	*p*-value
DTF_OD	1.66±0.48	2.10±0.61	**0.005**
DTF_OS	1.59±0.50	2.21±0.62	**0.001**
INT_OD	1.69±0.76	2.03±0.62	**0.008**
INT_OS	1.66±0.72	2.10±0.61	**0.001**
BUR_OD	0.21±0.08	0.23±0.08	**0.017**
BUR_OS	0.19±0.13	0.25±0.14	**0.002**

The values are presented as $\bar{x}$ mean ± standard deviation.

FIGURE 1. Mean values, standard deviation and p-value of some variables evaluated with Keratograph 5M at the beginning and after four hours in front of a screen. DTF (Tear film dynamics), INT (Tear film interferometry), BUR (Burning eye).

Discussion: The most significant results of this study were found in the visual fatigue questionnaire, showing an increase in the symptoms evaluated. Kim et al indicates in their research that these questionnaires are purely subjective and that the answers indicated by the subject may be conditioned by daily physical or mental contexts. There is currently no test that yields objective data related to visual asthenopia [1, 2]. Furthermore, in the evaluation with the Keratograph 5M,

a significant increase in the lipid layer of the tear film was evident both in the composition and dynamics concerning the measurements taken four hours after using the computer. Additionally, ocular redness was higher in the users of digital devices. There are studies that agree with our findings [3], such as that conducted by Chia-Chen Lin, which found that the thickness of the lipid layer showed a slight decrease related to short-term exposure to LED lighting (15 min) [4]. However, there is also research that contradicts our results [5], such as that by Golebiowsky that shows that there are no changes in the lipid properties of tears after one hour in front of a digital screen [6].

Conclusions: Frequent VDT users may have conjunctival redness and changes in tear lipid layer composition after four hours of backlit screen use. These alterations are related to the patients' symptomatology, evidenced by visual fatigue questionnaires.

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The role of scleral stiffness on corneal biomechanics using finite element analysis

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Aim: Corneal biomechanics provides information about the corneal tissue, which is of help to clinicians in the early diagnosis of different eye diseases, such as keratoconus [1]. These days, investigating corneal biomechanics is gaining attention as a disease biomarker. However, little is known about how the boundary structure, i.e., the sclera, might alter corneal biomechanical readings [2]. A recent study performed on donor eyes in which scleral rigidity was pharmaceutically modified proved that scleral stiffness directly affected corneal mechanical behavior [3]. Consequently, this article aims to investigate the role of scleral stiffness on corneal maximum displacement during mechanical stimulation using a finite element model (FEM).

Experimental method: A three-dimensional finite element model including the cornea, the anterior sclera and the vitreous was implemented (Figure 1a). These materials were defined as hyperelastic, following the parameters accessible from the literature [4] and applying a Holzapfel and Yeoh model for the cornea and the sclera, respectively. To achieve a realistic model, corneal fibers were taken into consideration. To mimic the mechanical stimulation of the cornea, an air-puff was simulated following the characteristics of commercially available tonometers. Intraocular pressure was fixed to 18 mmHg.

Once the model was completed, scleral stiffness (parameter C10) was modified from 0.4MPa (soft sclera) to 1.6 MPa (hard sclera) and the corresponding maximum corneal deformation amplitude was evaluated.

Results: Scleral stiffness greatly influenced maximum corneal deformation amplitude, as shown in Figure 1b. The relationship between scleral stiffness (SS) and maximum corneal deformation amplitude (MCDA) calculated in this work can be defined as MCDA = 0.1995 x ln (SS) - 2.7, MCDA expressed in mm and SS in MPa.

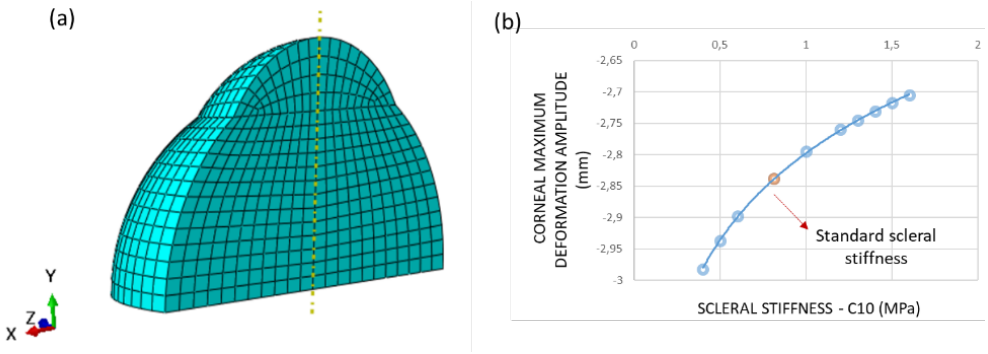

FIGURE 1. The implemented FEM model **(a)** and the variation of corneal maximum deformation amplitude as a function of scleral stiffness **(b)**.

Discussion: For a given cornea, the harder the sclera, the smaller the maximum deformation amplitude, and vice-versa. Biomechanical investigation of corneal tissue properties should take scleral stiffness into consideration because it modifies biomechanical corneal results.

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2.2. CONTACT LENSES

Comparison of soft toric contact lenses with and without prism ballast stabilization system

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Aim: To evaluate the effect of the prismatic effect induced by a soft toric contact lens stabilization system on lens power and lens image quality, not only from a paraxial point of view, but also from a wavefront perspective.

Experimental method: The sample included 56 soft toric contact lenses, 27 prism ballast designed contact lenses and 27 with a dynamic stabilization system. The contact lenses were manufactured from silicone hydrogel material made to order with different prescriptions, meaning that they had different spherical and cylindrical combinations. Both groups included the same prescriptions and were measured with NIMO (Lambda-X, Belgium), an instrument based on the Schlieren phase-shifting method, which measures soft contact lenses immersed in saline solution. Power (sphere and cylinder), spherical aberration (primary and second), coma and RMS (root mean square of Zernike coefficient) measured in a 4.5 mm diameter were analyzed. Primary spherical aberration and the two astigmatism terms were removed for the RMS calculation defocus, while the rest of the Zernike coefficients (up to heptafoil x (Z35)) were considered. Sta-

tistical analysis was performed with Statgraphics Centurion v19, using a one-way ANOVA test with a 95% confidence level.

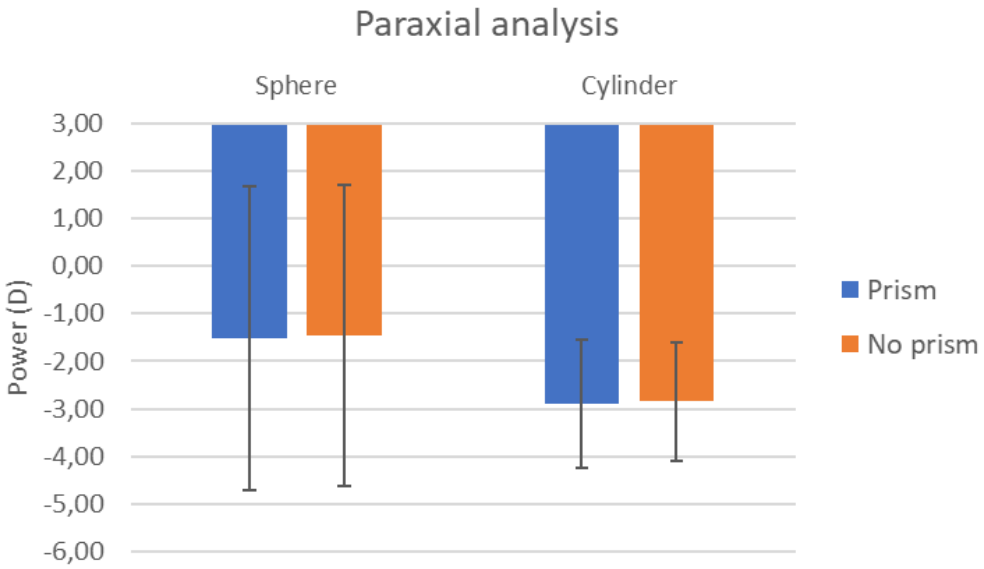

FIGURE 1. Sphere and cylinder results for prism and no prism ballast stabilization system. Bars show the standard deviation.

Results: The power difference between a stabilization system with and without prism ballast was (0.04±0.22) D and (0.06±0.10) D for both sphere and cylinder, respectively (Figure 1). This difference was not statistically significant. Using wavefront analysis, the RMS difference between wavefronts was (0.03±0.05) microns, which was not statistically significant (Figure 2). Differences found in some the most relevant Zernike coefficients affecting visual performance, such as coma and spherical aberration, did not show statistically significant differences (p-values>0.05).

Discussion: Both stabilization systems for soft toric contact lenses demonstrated similar performance, considering both paraxial and wavefront perspectives. Previous published papers showed a similar amount of prism induced into the optical zone [1] and concluded that the amount of the prism induced could produce binocular issues in patients with decompensated binocular vision. However, the wavefront analysis performed shows that the amount of prism is close to the limit considered significant for vision (considering that according to Marechal's criteria, the RMS difference is lower than $\lambda/14$; being λ=546nm) [2]. This result justifies further research in this direction to clarify

the influence of prism ballast in the quality of vision, even if is manufactured out of the optical zone.

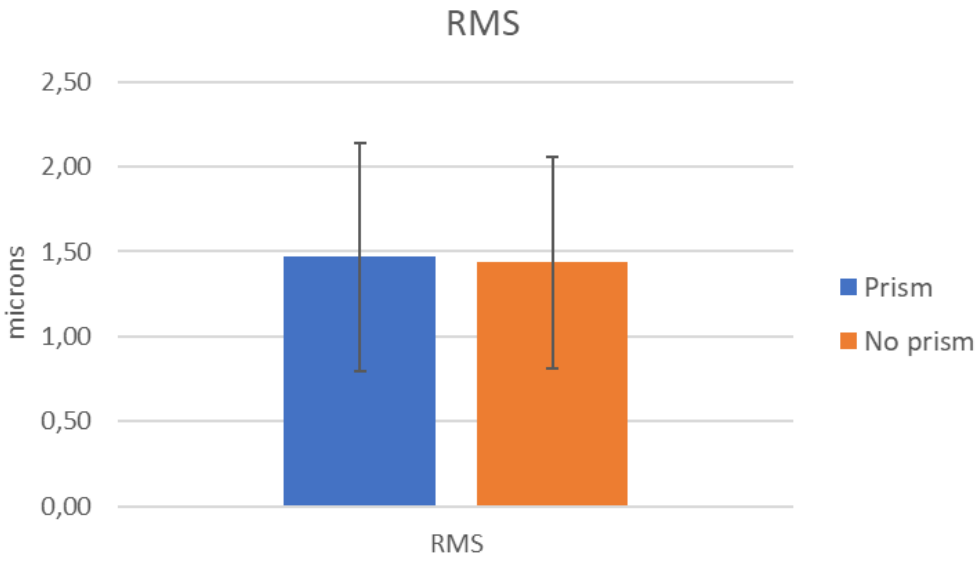

FIGURE 2. RMS (root mean square) results for prism and no prism ballast stabilization system. Bars show the standard deviation.

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Effects of contact lens wear and computer use on the ocular surface

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Aim: This study aims to assess the potential additive effects of contact lens wear and digital display use on the ocular surface and tear film along with the therapeutic benefits of artificial tear instillation.

Experimental method: Thirty healthy volunteers (10 men and 20 women) aged between 18 and 25 (21.7 ± 2.5 years old) participated in this prospective and controlled clinical study. The ocular surface and tear film of the participants were evaluated before and after executing a 20-minute reading task on a computer. Participants completed a total of three study visits: with and without contact lens (CL) wear and with CL and artificial tear instillation (Systane® Ultra, Alcon SL, Geneva, Switzerland). The order of the sessions was randomized. Participants were fitted in both eyes with a daily disposable silicone hydrogel CL (Dailies Total One®, Alcon Laboratories Inc. Fort Worth TX, USA). Each condition was evaluated on separate days. To reduce the variability of the tear film between visits, each session was carried out on the same day of the week, at the same time of day and under controlled environmental conditions (temperature and humidity). Measurements included the Ocular Surface Disease Index (OSDI) and 5-item Dry Eye Questionnaire (DEQ-5), as well as the measurement of tear meniscus height (TMH), noninvasive keratograph break-up time (NIKBUT) and bulbar conjunctival redness (BR) obtained using the Keratograpgh 5M device (Oculus Optikgerate, Wetzlar, Germany).

Results: Significantly higher dry eye symptoms (OSDI and DEQ-5) were obtained after reading on the computer with and without CL wear compared to before ($p \leq 0.001$). Similarly, BR was significantly higher and NIKBUT significantly shorter after reading on the computer, regardless of whether CLs were worn ($p \leq 0.02$). Regarding tear volume, TMH increased significantly after reading without CLs ($p < 0.0005$), although it remained unvaried with CL wear ($p = 0.23$). On the other hand, no significant changes were observed in any pa-

rameter after the use of the computer and CL wear with artificial tear instillation ($p \geq 0.55$), except for a significant increase in TMH ($p = 0.001$). Finally, CL wear during computer reading did not lead to greater dry eye signs (NIKBUT and BR) compared to naked eye reading ($p > 0.05$). In contrast, artificial tear instillation led to a smaller increase in dry eye symptoms compared to naked eye reading ($p \leq 0.02$) and CL reading without artificial tears ($p < 0.0005$), as well as to a lower increase in BR compared to the computer naked eye scenario ($p = 0.04$).

Discussion: Modern CL materials and disposable wearing modalities can prevent an additive effect between CL wear and short-term digital display use. The instillation of artificial tears is an effective strategy for preventing the impact of display use on the eye surface in CL wearers. Further studies are required to evaluate the impact of digital display use and CL wear for longer periods.

2.3. INTRAOCULAR LENSES AND REFRACTIVE SURGERY

Advanced biometric calculation: a case series

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Aim: Due to the high level of importance that correct calculation of intraocular lens (IOL) power has on final surgery outcome, for many years, different mathematical models have been developed that look to optimize this calculation. Even so, despite all these improvements, the refractive outcomes remain variable, especially in cases where the ocular anatomy, or particular eye parameters, differ from the normal, as occurs in eyes with high corneal astigmatism and in those with previous corneal refractive surgery. Our aim is to describe different methods of calculation that we can use according to the pre-operative refractive error and the ocular surgical history of the patient and to assess their predictive efficacy.

Experimental method: A case series of patients diagnosed with cataract, with different visual needs, and scheduled for surgery at the Nuestra Señora de Gracia Provincial Hospital in Zaragoza were analyzed: 1) Patient with previous myopic LASIK surgery, for whom specific formulas were used such as Pearl-DGS, EVO, Barrett True K post-refractive or the ASCRS's calculator, for the IOL power calculation; 2) Patient with corneal astigmatism of –1.90 D who was proposed to make paired corneal arcuate incisions with a femtosecond laser, according to the

Castrop nomogram; 3) Patient with corneal astigmatism of –3.50 D and IOL toric power calculated with the Kane Toric, Barrett Toric and ZCT calculator (Johnson&Johnson calculator). The biometer used in all cases was the IOL Master 700 and the residual refraction was done on the last visit, one month after the surgery in case 1 and 3 and three months later in case 2.

Results: 1) The four formulas used to calculate IOL power, keeping mind the pre-LASIK ocular parameters, predicted an IOL power of +18.00 D, looking for the first negative Spherical Equivalent (SE). After implanting this IOL, a residual error of –0.25cylinder (cyl) with –0.12 D SE was obtained and the Snellen visual acuity (VA) without correction was 1.0. 2) According to the Castrop nomogram, at 79 years old and with a corneal astigmatism of –1.90 D, two corneal arcuate incisions were made, with 51° of arc length in the meridian of 86° in the optic zone of 8.5 mm. On the last review, the patient was –0.75sphere (sph) with –0.75 D SE, and AV ETDRS without correction 0.28 and corrected 0.08. 3) On the IOL toric calculation, the formulas used estimated a similar power of +22.00 D with 6.00 D of cylinder. After surgery, the residual refraction was +0.25sph –0.75cyl 127° with –0.12 D SE. The Snellen VA without correction was 0.7, while when corrected it was 1.0.

Discussion: The refractive outcomes obtained at cases 1 and 2 were very good, and they reflect the good predictive performance of the calculation formulas used, as shown in the outcomes, getting a high improvement in patients' VA. However, in case 3 the residual refraction obtained did not coincide with what the formulas had estimated. After analyzing possible causes of the calculation error, it was confirmed that it was due to a rotation of the implanted toric IOL, which produced the loss of the correct efficacy of the cylinder [1, 2].

Thanks to the new mathematical models developed in recent years, which have included important parameters like posterior corneal power, refraction and keratometry before refractive surgery, lens thickness and anterior chamber depth, as well as artificial intelligence in some methods, less and less refractive surprises are obtained. Even so, there are still unknown variables and others that are difficult to estimate or that influence these results, like effective lens position (considered the main source of error) or alterations caused by surgery or possible surgical complications, as occurs in the rotation of the toric IOL, with a notable refractive effect [3, 4].

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Analysis of the effects of visual quality under different light conditions with monocular implantation of different intraocular lenses: a pilot study

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Aim: Cataracts are the leading cause of reversible blindness and low vision worldwide. In recent years, different types of IOLs have been developed to improve vision while decreasing dependence on glasses. [1] The aim of this study is to compare the effects on visual function and quality of life under different photopic and mesopic light conditions in patients undergoing cataract or refractive lensectomy with monocular implantation with different models of lenses.

Experimental method: Observational, prospective, cross-sectional pilot study of 14 eyes belonging to 14 patients between 59 and 82 years old (70.5 ± 8.6 years old) who underwent cataract surgery by phacoemulsification with different types

of intraocular lenses: Tecnis® Eyhance™ (Johnson&Johnson Surgical Vision, Inc., Santa Ana, CA) with Monofocal plus, Diffractive design, the PhysiOL® IsoPure 123™ (BVI Medical/PhysIOL, Liége, Belgium) which is an EDOF, Isofocal Aspherical lens and finally AcrySof ® IQ Vivity™(Alcon Laboratories, Inc., Fort Worth TX.) with EDOF, Non-Refractive design, all operated by the same experienced surgeon (E.D.R).The study was approved by the Ethics Committee at San Carlos Clinical Hospital in Madrid and conducted in accordance with the Declaration of Helsinki. The patients involved met the inclusion and exclusion criteria for participation in the study and signed an informed consent form. All patients were evaluated the day after the intervention, one week and one month after intraocular lens implantation in one eye. During these time periods, measurement of the patients' manifest refraction and monocularly corrected visual acuity was obtained at a far distance of four metres (m), an intermediate distance of 66 centimetres (cm) and near distance at 40 cm. The test used was the EDTRS test, under photopic illumination conditions of 84 cd/m2 and mesopic illumination of 3 cd/m2 maximum with correction, after 15 min with dark adaptation. A complete ophthalmological examination was also performed. The statistical software SPPS version 28 was used for analyzing the data obtained in this study. The normality of the data samples was assessed using the Kolmogorov-Smirnov test. When a non-parametric analysis was obtained, the Wilcoxon test was used. A p-value of less than 0.05 was considered a criterion for statistical significance.

Results: Statistically significant values were only obtained when comparing near visual acuity in photopic illumination conditions between Eyhance and Vivity lenses with a value of 0.013, since no statistically significant values were obtained between the lenses at the different distances and between photopic and mesopic conditions.

Discussion: Patients at younger ages have greater visual demands and therefore require good vision at all distances, especially at intermediate distances due to the emergence of new technologies. For this reason, there is a continuous evolution of IOL designs. In the study by Auffarth et al [2], in the study by Bova, et al [3] and in the study by Arrigo, et al [4] it is observed that the three lenses studied obtain good visual acuities. This is not comparable with our study, however, as there is no research in which subjects with a monocular implantation and the analyzed IOLs have been studied, in addition to the different illumination conditions.

Conclusion: All three IOLs provided good visual results at far, intermediate and near distances under both photopic and mesopic conditions. Overall, there were no statistically significant differences, except for the photopic illumination conditions of the Eyhance and Vivity lenses. However, since this was a pilot study, future research is required to determine the results with longer follow-up times and larger sample sizes with these types of IOLs.

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Calculation formula prediction of intraocular lens in cataract surgery depending on the axial length

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Aim: The main objective of this study is to find the best formula to obtain maximum accuracy in post-surgery results depending on the size of the eye: small eye (AL < 22 mm), normal eye (22mm < AL < 26 mm) and large eye (AL>26 mm).

Experimental method: The sample taken for the study is formed by a total of 447 subjects which underwent cataract surgery by different surgeons at Nuestra Señora de Gracia Hospital in Zaragoza. An eye was selected from each patient, totaling 224 right eyes (OD) and 223 left eyes (OI). Of all the patients, 178 were men and 269 were women. The utilized LIOS were calculated by using the SRK-T formula. LIO AMO Tecnis 1 ZCBOO (Abbot Medical Optics) ® was implanted in 330 patients, EyeCee ONe (Bausch & Lomb) ® to 57 and 60 had Physiol Micro+A 123(Medical Mix) ® implanted. Once all the data was collected, without taking AL into account, a study was conducted on forecasting the

different formulas for the total of the sample. SRK-T postoperatory results were compared to the preoperatory forecast using the Hoffer, Haigis Hill, Kane, Barret, Ladas and EVO formulae. The sample was then divided into subgroups of short eyes (AL < 22 mm), normal eyes (22mm < AL < 26mm) and large eyes (AL>26mm). Finally, the results were compared to see which formulas adjusted better, checking if the differences were statistically significant.

Results: In general, the best results were achieved using Kane and Hoffer Q formulas, followed by Ladas, EVO and SRK-T.

In short eyes, the formula with the lowest refractive error was SRK-T, reaching values near emmetropia, followed by Kane, EVO, Hill, Haigis, Ladas and Barret. The poor adjustment of Hoffer-Q stands out. The forecast was around values near null refractive error (±0.25D), more myopic in Hoffer, Kane, Ladas, and more hypermetropic for the rest of the formulas. For the normal eye cohort, the most accurate formulas were Hoffer-Q and Kane, followed by Haigis, SRK-T, Ladas and Evo. Barret and Hill presented the highest degree of error. The formulae for these subgroups had a better adjustment (less than +0.25D), as the errors were more positive. Values for large eyes were farther away from emmetropy, resulting in mixed results between the formulae and were clinically more significant. Hill was the most accurate one, followed by EVO, Kane and Ladas, Barret and Haigis, all with values of around +0.25D. In this case, SRK-T and Hoffer were the least accurate ones, reaching an approximate spheric equivalent difference (DIFEE) of +0.50D (Figure 1).

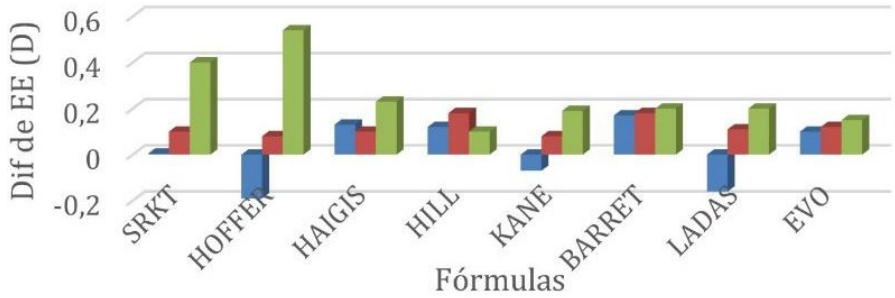

FIGURE 1. Bar graph with the prediction results for each of the studies formulas, divided into the different subgroups, short eyes (blue bar), normal eyes (red bar) and large eyes (green eyes). Dif: difference. D: diopter, EE: spheric equivalent.

Discussion: The extraction of cataracts is a surgical intervention that is very frequent around the world. For a long time, the end goal of cataract surgery has been to accomplish transparency of the means. Later, the focus shifted to restoration of the dioptric power of the eye after replacing the crystalline with a LIO to correct the refractive defects. Identifying the best LIO formula that predicts the post-sur-

gery refractive result is one of the most important factors in successful cataract surgery. (1) The refractive results obtained in the calculus made with the utilized formulas in this study are very accurate, with a deviation of less than 0.25D. On the other hand, in the case of normal eyes and large eyes, the subjective post-operatory values have been found to be more positive than the aforementioned ones, causing the need to find more myopic spheric equivalents. The Kane formula is the most accurate when AL is not taken into account. On the other hand, when AL is considered, the formulae shown to best fit each kind of eye are SRK-T and Kane for short eyes, Hoffer Q and Kane for normal eyes and Hill for large eyes. Haigis, Hill, Kane, Barret, and EVO show similar results along the different subgroups, which suggests that using one or the other makes little difference. Without taking AL into account, the best formulas are SRK-T and Kane for short eyes, and Hoffer Q and Kane for normal eyes and Hill for large eyes. Haigis, Hill, Kane, Barret, and EVO worked on all the subgroups in the same way, which suggests that choosing one type or the other makes little difference.

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Comparison of biometric measurements obtained by two swept source technology based biometers and a corneal tomographer

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Aim: The purpose of this article is to compare the anterior keratometry (K), axial length (AL), anterior chamber depth (AC) and lens thickness (CT) parameters obtained with two swept-source technology biometers: Argos (Alcon Labs) and

IOL Master 700 (Zeiss) and to compare the keratometry (K) obtained with Pentacam (Oculus) with that obtained with both swept-source biometers. The accuracy of the calculation of intraocular lens power based on the above measurements was also determined.

Experimental method: This is a retrospective study, including 194 eyes (110 subjects), 55% of whom were women, 70.85 +/– 8.97 years old, diagnosed with cataracts and with no previous ocular pathology. Three measurements were performed with Pentacam and five with the IOL Master and Argos. All subjects were examined under mesopic conditions (1.20 lux). All subjects underwent cataract surgery at Clínica Rementería (Madrid). SPSS statistical software was used to determine the normality of the variables (Wilcoxon test) and the correlation between measurements (intraclass coefficient).

Results: Regarding keratometry (K), axial length (AL), anterior chamber depth (AC) and lens thickness (CT), no statistically significant differences were found between any of the three devices. High agreement rates (high ICC) were obtained when analyzing every device separately. Clinical differences were irrelevant (Tables 1-3).

	Argos	IOL master 700	P
AC	3,27±0,41	3,13±0,38	<0,001
AL	23,52±1,32	23,53±1,37	<0,001
CT	4,60±0,38	4,58±0,40	<0,001

TABLE 1. Comparison AC, AL, CT obtained with the Argos biometer and the IOL Master 700.

	K flat	K steep	K media	J0	J45
Argos	43,69±1,44	44,62±1,53	44,16±1,45	–0,06±0,40	0,01±0,40
IOL Master700	43,59±1,44	44,54±1,54	44,06±1,46	–0,03±0,37	–0,01±0,43
Pentacam	43,46±1,43	44,36±1,54	43,91±1,44	0,01±0,41	0,00±0,39

TABLE 2. Comparison of keratometry obtained with Argos, IOL Master and Pentacam equipment.

	K flat	K steep	K media	J0	J45
Argos vs Pentacam	p<0,001	p<0,001	p<0,001	p=0,012	p>0,05
Argos vs Iol700	p<0,001	p<0,001	p<0,001	p>0,05	p>0,05
Pentacam vs Iol700	p<0,001	p<0,001	p<0,001	p>0,05	p>0,05

TABLE 3. Comparison of the CCI of the keratometry obtained with Argos, IOL Master and Pentacam equipment.

When comparing IOL calculations and refractive outcomes of 63 patients, the absolute error decreased from 0.29 to 0.22 in 43.6% of the cases, increased in 3.2% of the cases and remained stable in 53.2% of the cases, according to Argos calculations. According to IOL master, absolute error decreased from 0.25 to 0.22 in 51.1% of the subjects, remained stable in 6.7% and increased in 42.2%.

Discussion: Our data agree with those obtained by Románek et al [1], with high agreement rates between IOL Master and Argos. Hussaindeen [2] found high AL correlation rates among children. We did not find differences according to age, like the aforementioned studies. Montés-Micó [3] compared six different devices, including those used in our study, and found very similar but not necessarily interchangeable measurements. Higashiyama [4] found differences between IOL Master 500 and Argos, but concluded that they were clinically irrelevant.

Conclusion: No relevant differences were found between Argos, IOl Master and Pentacam measurements.

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Corneal epithelial growth after LASIK: a case report

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Introduction: Epithelial growth (EG) is the presence of corneal epithelial cells at the flap interface following laser-assisted subepithelial keratomileusis (LASIK). It is infrequent after primary procedures, but the incidence may increase if the flap is raised during re-interventions [1]. The etiology may arise from the introduction of epithelial cells in the interface during the creation of the flap or due to the migration of epithelial cells from the edges of a poorly adhered flap. EG is usually a casual finding and remains non-progressive and asymptomatic in a high percentage of cases. However, it can affect vision or produce ocular surface symptoms on some occasions. Herein we report a case of EG with a striking anterior segment image.

Methodology: A 46-year-old woman presented with ocular discomfort in her left eye (OS) for 3 weeks. She reported a past history of corneal refractive surgery with LASIK technique in both eyes six years earlier.

Visual acuity without correction measured in LoGMAR scale for the right eye (OD) was 0.05 and 0.1 for the OS. Best corrected visual acuity was 0.1 in LogMAR scale in both eyes. The objective refraction was +0.25 (-1.25 x 76º) in OD and +0.25 (-1.00 x 33º) in OS. Slit-lamp biomicroscopy revealed an 8x1 mm ephitelial corneal irregularity in the LE, compatible with post-LASIK grade 2 epithelial growth. Moreover, fluorescein staining was negative and no anterior segment alterations were revealed. Intraocular pressure and fundus examination were normal in both eyes.

Corneal topography, corneal optical coherence tomography and anterior pole photographs were performed in both eyes to monitor this anterior segment disorder.

Results: A post-LASIK epithelial growth diagnosis was established. A conservative approach was chosen as a treatment by using artificial tears. In the following visits, no progression of the lesion or changes in vision were demonstrated.

The treatment of EG consists of lifting the flap to perform a mechanical cleaning of the epithelial cells of the interface. It is indicated in case of vision de-

crease due to the affect on the visual axis and/or irregular astigmatism or after flap melting [2]. The observed incidence of EG after LASIK varies from 0-3.9% in primary procedures to 10-20% in cases of flap lift for retreatments. However, treatment itself constitutes a risk factor for recurrence, so it is not recommended to treat asymptomatic and stable EG.

Conclusions: Post-LASIK epithelial growth is an uncommon complication. In most cases, it is asymptomatic and without visual repercussions, for which observation and follow-up is indicated.

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Preoperative refraction prediction after photorefractive keratectomy (PRK)

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Aim: This article aims to find a tool to predict preoperative ametropia in a patient operated for photorefractive keractectomy (PRK).

Experimental method: This retrospective study includes data on 34 eyes belonging 17 patients reviewed at Clínica Rementería (Madrid). The selected patients had undergone PRK-type corneal refractive surgery and did not present any ocular pathology. These patients underwent a corneal tomography with Pentacam (Oculus) equipment in a preoperative evaluation and three months af-

ter the surgical intervention. In this last examination, the parameter "refractive change" was analyzed on the Holladay Report map and compared to the preoperative subjective refraction. The Holladay report compares anterior and posterior corneal curvature to estimate the corneal ablation measured in diopters [1]. The anterior surface of postoperative corneas flattens, while the posterior surface is unchanged. This report is frequently used for cataract IOL calculation in patients with prior laser surgery. The Holladay report provides the reference spherical value and was compared with the spherical equivalent obtained by subjective refraction [2]. The data were analyzed with the statistical program SPSS, in which the Wilcoxon test was used for related samples.

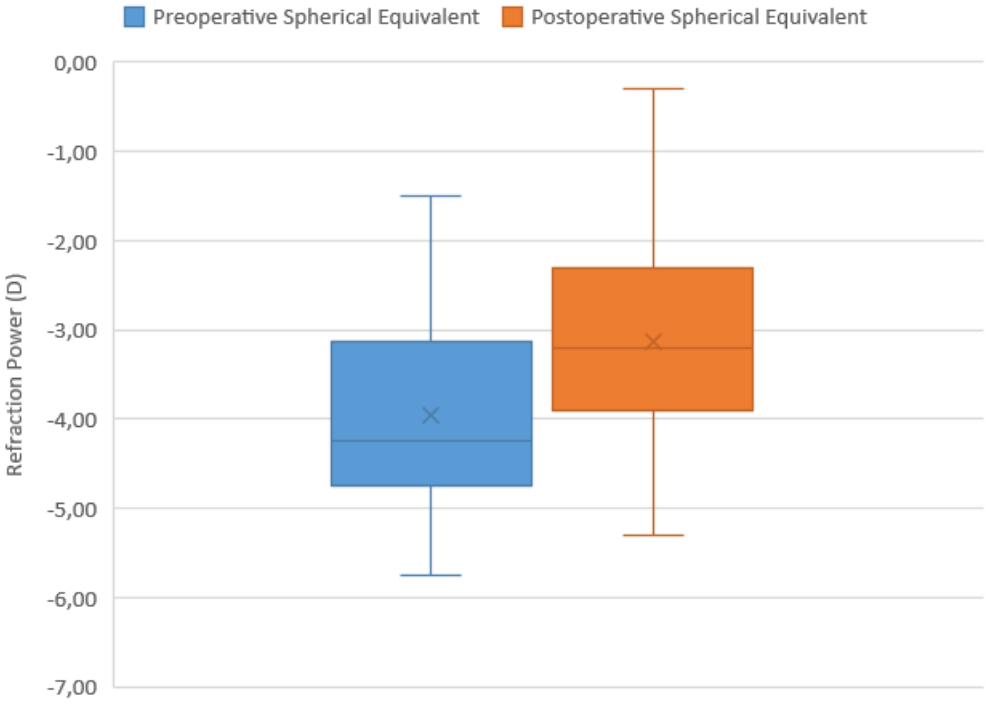

FIGURE 1. Comparison of preoperative and postoperative spherical refraction.

Results: The patient sample included in the study had a mean age of 30.9±5.1, with a preoperative refraction of –3.96±1.13 D. The postoperative spherical prediction with Pentacam was –3.13 ±1.19D. The mean difference was –0.83±0.52D. Statistical analysis showed a statistically significant relationship between both values ($P < 0.05$), which was also clinically significant. In patients with astigmatism, the difference between the preoperative subjective spherical equivalent and that obtained in the Holladay report three months after surgery was greater than in patients with only spherical ametropia.

Discussion: The Holladay report could be a useful resource to predict preoperative ametropia and should be taken into account when preoperative refraction is unknown, especially for IOL calculation before cataract surgery. Differences between media are non-clinically relevant (less than 1D). Both parameters may be interchangeable, but this should be assessed in further studies including more subjects. No related studies to compare have been found.

Conclusions: The Holladay report map is a useful tool for predicting preoperative refraction in patients who underwent PRK surgery when we do not know their preoperative subjective refraction.

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Visual performance and defocus curve after implantation of a new trifocal intraocular lens

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Aim: The purpose of this article is to evaluate the visual performance and to obtain the defocus curve after implantation of a new trifocal intraocular lens (IOL).

Experimental method: A total of 44 eyes belonging to 22 patients (12 female and 10 male) were enrolled in this observational prospective study after implantation of the Liberty trifocal IOL (Medicontur). The age of the patients was 59

± 9. Defocus curves (the step size in diopters was 0.50 D, ranging from +3.00 to –5.00 D) were obtained monocularly under photopic conditions three months after surgery and the optotype used was ETDRS. Patient satisfaction was evaluated by a scale from 0 to 10 with different sections (general, distance, intermediate and near vision and presence of halos), with 10 meaning complete satisfaction in the vision section and 0 meaning not perceiving/bothered by halos and 10 very concerned about halos in the halo section. The questionnaire used was an adaptation of the National Eye Institute Visual Functioning Questionnaire 25 (NEI VFQ-25) scale, using only the sections that we considered most relevant. Furthermore, postoperative refraction and visual acuity at far, intermediate and near distances were measured both after one month and three months. Percentages were used to represent the results of the general satisfaction of the patients. Statistical analysis of the results was carried out using SPSS for Mac v.26.0.0 (SPSS Inc., Chicago, IL).

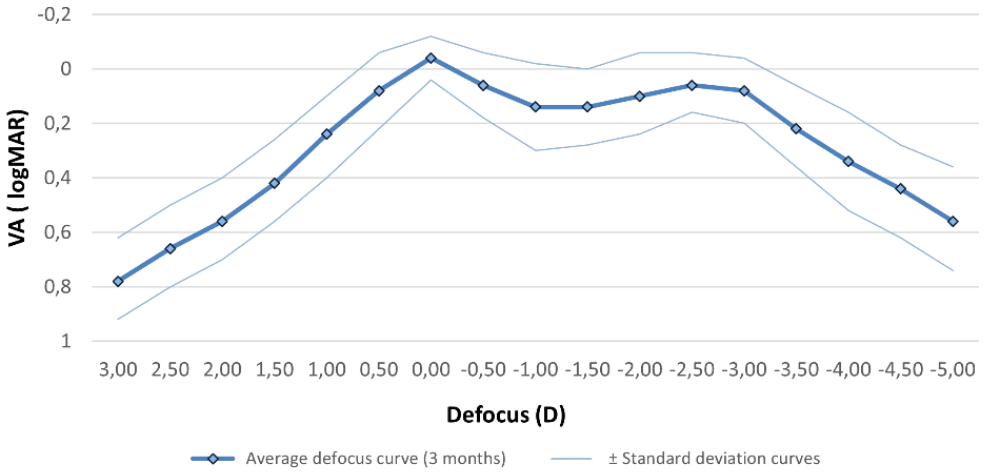

FIGURE 1. Average defocus curve three months after intraocular lens implantation. VA: Visual Acuity.

Results: One month and three months after surgery, the spherical equivalent was –0.09 ± 0.26 D and –0.06 ± 0.21 D, respectively. Visual acuities at three months of follow-up were 0.02 ± 0.09, –0.06 ± 0.07, 0.09 ± 0.20 and 0.28 ± 0.17 logMAR for uncorrected and best-corrected for distance, and best-corrected for intermediate and near distances. The defocus curve at three months (Figure 1) showed excellent far and near vision and good intermediate vision. The average response to visual satisfaction queries was 7.85/10 at general vision, 7.79/10 at far (distance), 7.57/10 at intermediate, 8.71/10 at near and 5.69/10 at the presence of halos.

Discussion: Trifocal IOLs lens implantation has increased in recent years, given the large number of middle-aged people who require good intermediate vision. Several systematic reviews and meta-analyses have shown the benefit of using these lenses in terms of visual performance [1-4].

Conclusions: Patients implanted with the Liberty trifocal IOL have shown a significant improvement in visual acuity in different distances showing high overall satisfaction. The results obtained show that this lens is predictable.

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2.4. OPTICS AND INSTRUMENTATION

Anatomical changes in the retinal capillary plexuses assessed by Optical Coherence Tomography Angiography in type 2 diabetic patients with moderate diabetic retinopathy: descriptive study of a series of cases

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Aim: The purpose of this article is to assess anatomical changes in the retinal superficial capillary (SCP) and deep capillary (DCP) plexuses, as well as choriocapillary (CC) in patients with type 2 diabetes mellitus (DM2) with moderate diabetic retinopathy (DR) and without diabetic macular edema (DME) using optical coherence tomography angiography (OCTA) through a descriptive study of a series of cases.

Experimental method: Fifty-four patients with DM2 with moderate DR but without DME were included. All participants underwent a complete visual examination, including best corrected visual acuity (BCVA), IOP measured by Goldmann tonometry, axial length (AL) and OCTA examination using deep-range imaging with the DRI-Triton SS-OCT. A complete history with clinical variables was also performed. The anatomical alterations studied in this work have been peripheral disruption of the foveal avascular zone (FAZ), vessel dilation, microaneurysms (MAs), intraretinal microvascular abnormalities (IRMAs), flow changes and lack of perfusion in CC. In DM2 patients, OCTA anatomical changes were described as a percentage of the total, considering 0% as the absence of the anatomical alteration and 100% as the maximum presence of it.

Results: The mean age of the 54 DM2 patients was 64.1 ± 12.0 (42-86). Peripheral disruption of the FAZ was observed in SCP and DCP (83.3% and 64.2% of the patients, respectively), while MAs were observed in SCP and DCP (79.6% and 81.1% of the patients, respectively). Dilatations and IRMAs were detected in both plexuses. The dilatations were 48.1% in SCP and 22.6% in DCP and the IRMAs were 46.3% in SCP and 20.8% in DCP. Due to flow changes, they were detected in SCP and in DCP (66.7% and 81.1%, respectively). In case of CC, a lack of perfusion was found in 18.0%.

Discussion: The incorporation of OCTA has been a great advance for the diagnosis, treatment and monitoring of some retinal diseases. In addition, it is a fast and non-invasive structural technique that can provide a lot of information about the anatomical alterations and retinal vascularization in the different plexuses and the FAZ.

Our results show that retinal vascularization is affected in DM2 patients with moderate DR without DME. We can find anatomical alterations in both plexuses (SCP and DCP), such as peripheral disruption, dilatations, MAs, IRMAs, flow changes and a lack of perfusion in CC. Other authors such us Lupidi et al. (1) also found anatomical alterations similar to ours. They described abnormalities in both SCP and DCP. They found a higher number of linear vascular dilatations and a smaller number of MAs. Hwang et al. (2) also found a lack of capillary perfusion in the SCP and in the DCP, in addition to vascular dilatations in the DCP.

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Choroidal thickness difference with or without the use of the built-in software segmentation modifying tool in swept-source OCT

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Aim: The purpose of this article is to compare choroidal thickness (CT) automatically calculated by the built-in mapping software and those obtained using the built-in segmentation modifying tool.

Experimental method: Cross-sectional and prospective study in which 45 eyes belonging to 45 healthy patients aged between 18 and 50 were included. All patients underwent a comprehensive ocular examination. Only eyes with axial length (AL) between 22-26 mm and spherical equivalent (SE)>-5.00D were included. CT measurements were performed using the 12 mm radial scan pattern with swept-source OCT (DRI-1 Atlantis, Topcon Medical System, Japan). CT was defined as the distance between the posterior edge of the hyper-reflective retinal pigment epithelium (RPE) and the choroidal junction. CT was automatically calculated by the software and defined by the Early Treatment Diabetes Retinopathy Study (ETDRS) style grid in nine subfields. The built-in segmentation modifying tool was used to inspect each line and to manually correct the inner and outer bounda-

ries to obtain the CT after manual adjustment. The Kolmogorov-Smirnov test was used to analyze the normal distribution. Bland-Altman plotting was used to compare CT before and after manual line modification in each ETDRS subfield.

Results: Mean age was 32 ± 9.10 years, mean SE was –0.55 ± 1.31 D, mean AL was 23.42 ± 0.92 mm and mean index quality score of choroidal images was 60 ± 23. The Bland - Altman plotting showed that CT after line adjustment generally yielded thicker choroid over the range of 5-6 µm in the subfoveal area and inner ring compared to CT without using the segmentation modifying tool. The greater difference was observed in the subfoveal area (7.2 µm) and the smaller difference in the inner (2.2 µm) and outer (0.9 µm) ring of superior subfield.

Discussion: The evaluation of the choroidal layer using OCT has exponentially increased and has become an important examination tool in clinical practice [1]. Since Spaide et al. [2] developed an EDI-OCT to improve choroidal visualization, several studies analyzed the choroid of healthy [3] and pathological eyes [4] with more detailed images. The introduction of swept-source OCT, which uses a longer wavelength and enables greater penetration, enhances the junction visualization between the choroid and scleral layer [1, 3, 4]. This device incorporates a built-in mapping software that reports automatically CT, which can be adjusted by the built-in software segmentation tool. The choroid has an important function supplying the outer retina with oxygen and nutrients and plays an important role in the mechanism regulating eye growth [5]. For that reason, there cannot be a misinterpretation of its thickness in clinical practice that could mask inexistent anomalies. Our results demonstrated that there is a significant difference between CT using a segmentation tool according to the results reported by Moussa et al. [6] in an Egyptian population.

Conclusions: CT was higher using the built-in segmentation tool than those automatically calculated by the built-in mapping software. These outcomes must be considered in clinical practice to avoid biased results.

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Comparison of corneal radius and corneal conic constant of both meridians measured with a new eye surface profiler and a Placido-ring videokeratograph

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Aim: The purpose of this article is to evaluate and compare the measurements of a Steep corneal radius (Rs), Flat corneal radius (Rf), Steep Corneal conic constant (Qs) and Flat Corneal conic constant (Qf) using anterior eye profilometry (Eye Surface Profiler, ESP, Eaglet-eye) and a conventional Placido-ring topographer (Keratron Scout, Opticon 2000).

Experimental method: This retrospective study enrolled 40 right eyes belonging to 40 patients. Exclusion criteria were corneal or scleral pathology and the

use of orthokeratological contact lenses. All parameters were obtained by the same experienced examiner and under the same conditions.

The Eye Surface Profiler is a Fourier domain profilometer that consists of two blue-light projectors with a yellow filter. Sodium fluorescein is needed to capture the images (1). With this instrument, radii were measured in a diameter of 3 mm but the eccentricity was measured in a diameter of 6 mm. Keratron is a Placido topographer which measures the corneal radius in a diameter of 3mm and the diameter for the eccentricity was set at 6 mm.

For data processing, measurements of radii and conic constants obtained with both videokeratoscopes were compared. Firstly, the normality of the data was check using the Shapiro-Wilk test. The paired Student t-test with Bonferroni correction was used to compare the mean of each parameter ($p<0.05$). Bland-Altman plots were performed after checking the normality of the differences. All statistical analysis was performed with Microsoft Office Excel (Microsoft Corp.) and R commander.

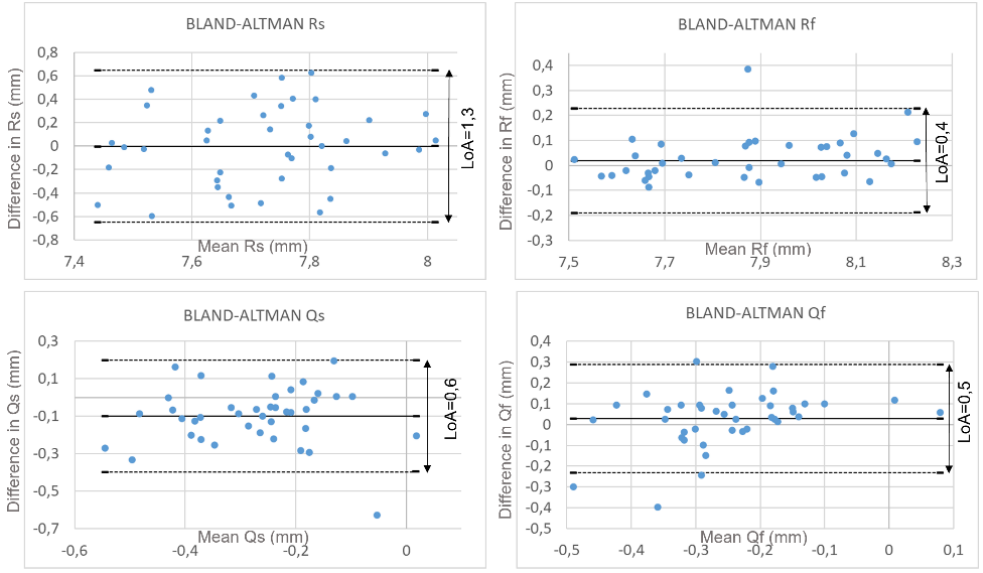

FIGURE 1. Bland-Altman plots for all the parameters. LoA = Limits of agreement (95%). Where the x-axis is the means of the values and the y-axis the difference between both instruments. The mean difference is the solid line. The 95% limits of agreement are the dotted lines.

Results: The mean age of the participants was 19.0±1.7 years. The mean Rs was 7.7 ± 0.2 mm with the ESP and 7.7 ± 0.2 mm with the Keratron, the mean Rf was 7.9 ± 0.2 mm with the ESP and 7.9 ± 0.2 mm, the mean Qs was –0.3 ± 0.2 with the ESP and –0.2 ± 0.2 with the Keratron, the mean Qf was –0.2 ± 0.3 with the ESP

and –0.3 ± 0.1 with the Keratron. All parameters analyzed with the Saphiro-Wilk test have a normality distribution. In all the measures of the parameters, the p-value was higher than 0.0125 (with the Bonferroni correction) so there were no statistically significant differences between the measurements of both instruments.

In the Bland-Altman plots (Figure 1), it can be observed that the Rf is the parameter with the lower value (0.4 mm) for the 95% limits of agreement (LoA) compared with the other parameters that have similar values, except the Rs that has the highest value (1.3 mm) which is the parameter with more difference between the measurements of both instruments.

Discussion: In conclusion, the parameter with the most difference between the measurements from both instruments was Rs, whereas the others have lower values of LoA. There were no statistically significant differences between both instruments (p-value>0.0125). The agreement between the measurements of both instruments is strong, but more studies are needed for validating the reliability of the ESP.

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Corneal characterization in diabetes mellitus patients: pilot study

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Aim: The purpose of this article is to determine whether there are corneal changes between diabetic patients that underwent cataract surgery.

Experimental method: All the subjects were patients from FISABIO Medical Ophthalmology in Valencia (Spain) and underwent a complete optometric evaluation before cataract surgery. Patients with previous eye surgery or retinal damage were excluded. The sample was compounded by 127 eyes split into two groups in this prospective study. The control group included 87 healthy patients with no systemic previous pathologies. The experimental group was formed by 40 patients with diabetes mellitus (DM). Exclusion criteria were previous eye surgery, glaucoma or any corneal damage. Pachymetric data were median anterior and posterior radii (Rmant and Rmpost, respectively), horizontal and vertical densitometry (DH and DV, respectively) and apex pachymetry (AP), which were measured using Pentacam®. Endothelial cell density was measured with Nidek CEM-530. Corneal edema was determined 24 hours after surgery by biomicroscope.

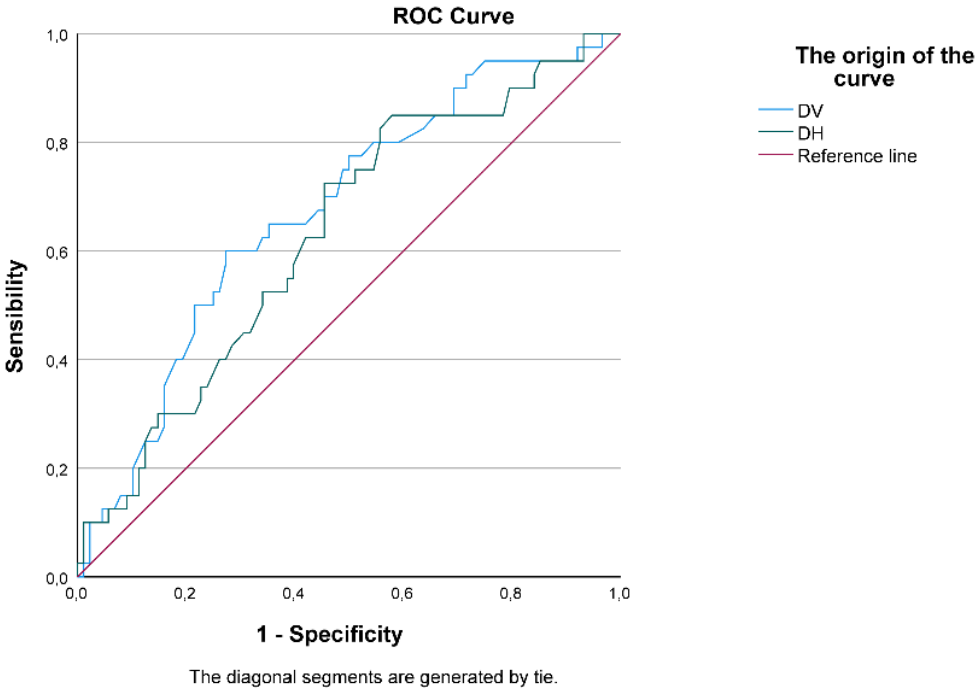

FIGURE 1. Receptor Operative Curve of DM patients to determine the predictive power of horizontal (green) and vertical (blue) densitometry.

Results: Both samples followed non-parametric distributions (Kolmogorov Smirnov $p<0.05$). The mean age for the control group was 76±8 years and 79±6 years for the experimental group. U Mann-Whitney was statistically

significant for age (U= 3001, p= 0.035), DH (U= 1298, p=0.018) and DV (U=1149.5, p=0,002). Correlations were found using Spearman's Rho. Gender showed correlations to DM (ρ=0.176, p= 0.016), AP (ρ=-0.212, p= 0.008) and Rmpost (ρ=-0.283, p< 0.001). Age correlated to edema (ρ=-0.181, p= 0.026), DM (ρ=-0.156, p= 0.034), DH (ρ=0.302, p< 0.001) and DV (ρ=0.314, p< 0.001). Edema correlated to age (ρ=-0.181, p=0.026). Finally, DM showed correlations to DH (ρ=0.211, p=0.017) and DV (ρ=-0.279, p=0.001). Main components analysis showed C1=-0.148*Gender+0.529*Age+0.916*DH+0.932*DV and C2=0.848*Age+(-0.321)*DH+(-0.204)*DV. Receiver Operating Characteristic curves (ROC) plotted to measure the predictive capacity of DH (AUC=0.631, p=0.018) and DV (AUC=0,673, p=0.002) in the DM diagnosis, however, showed poor results, slightly better for DV.

Discussion: The effects of DM in the retina have drawn most of the research interest so far.[1] Nevertheless, the ocular surface can provide very valuable information in the DM visual characterization. In this study, we found significant correlation between DM and gender, age, DH and DV.[2] Additionally, analysis of the main components revealed that these variables were important to build a predictive model for DM. Besides, DH and DV values were higher in DM patients as seen on previous studies.[2] However, other studies suggest different results may be due to the size of the sample.[3] Finally, the ROC curve was plotted to test the predictive power of DH and DV on DM visual impairment with acceptable results. Further research needs to be carried out to achieve deeper understanding of the effects of DM on the cornea using the duration and type of the disease as variables.

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Development of an algorithm to track blinks from a face video

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Aim: Blink characteristics are affected in the short term while patients wear contact lenses [1]. This paper develops an algorithm to study the comfort of patients using contact lenses.

Experimental method: The study was conducted in Matlab. First, the eye was detected using the Viola-Jones Algorithm [2]. Once the picture of the eye was cropped (Figure 1A), an averaging filter was applied to reduce the amount of intensity variation between adjacent pixels. The filter size selected was 1/10 the size of the cropped eye image to remove the noise of the image. In each frame of the video, the mean intensity value in each row of the eye picture was stored (Intensity Vertical Projection Analysis [3]). The darkest rows were, in an open eye frame, at the upper lid located in the upper side of the frame (between 0%-50% of the total vertical image size), but in the closed eye the darkest rows were located in the bottom side of the frame (between 50%-100% of the total vertical image size) (Figure 1B). Frames with the darkest row position higher than 50% were considered part of a complete blink. The threshold for partial blinks was calculated using the cumulative density function of the darkest row of each eye frame in the video, with most of them considered noise (Figure 1C). Partial blink frames were considered to have less than a 5% probability (95% of confidence interval, Figure 1F). Once the blinks were located, the duration was calculated finding the time positions at both sides with values higher than the mean value of the significant darkest row of the video graph plus the standard deviation (Figure 1D).

Results: The number of blinks and the video time when the complete and incomplete blinks were happening are shown in Figure 1C and can be seen in the

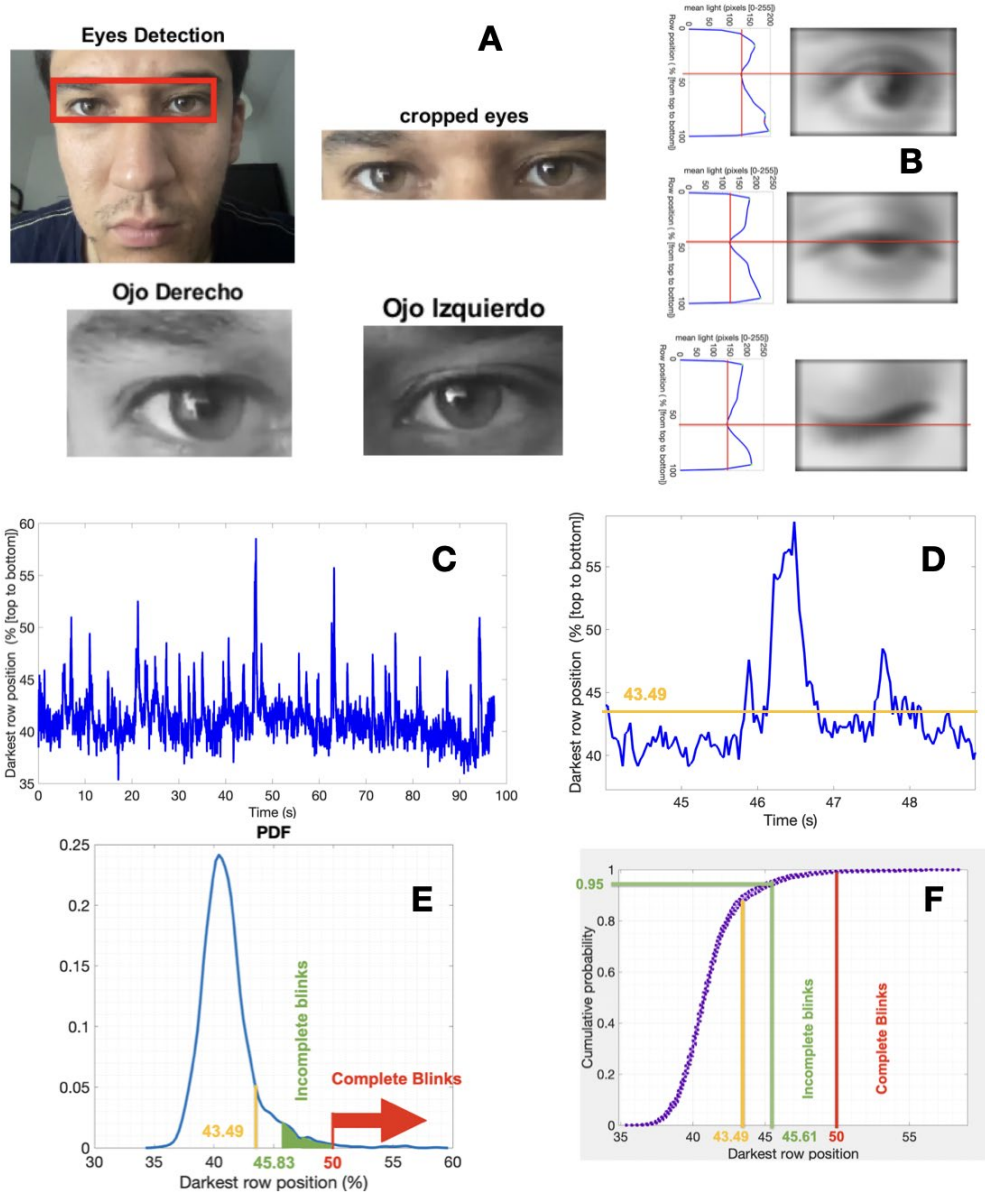

FIGURE 1. **A)** Viola-Jones Algorithm; **B)** Darkest row position; **C)** Darkest row position vs Time; **D)** Zoom in plot C; **E)** PDF of plot C; **F)** CDF of plot C.

position of the significant dark row. The peaks show a partial or complete blink depending on if it is higher than 50%. Figure 1D shows a complete blink, a zoom

of the plot in figure 1C. Figure 1E is the density of the first function. The primary valley shows the most probable position that includes all the frames where the eye is open. The secondary valley peak is due to the partial blinks in the video. In Figure 1F, the cumulative function illustrates the probability of obtaining a certain position on the frame. The result of the example tested for the complete blinks are that the duration of the blink was 0.57 s and its standard deviation was 0.23 s. The interval of the blink was 17.47 s±11.67 s (mean±standard deviation). For the incomplete blinks, the blink duration was 0.29 s±0.10s and the blink interval was 4.3 s±2.75 s. All the results shown were tested on other videos with different lengths and illuminations.

Discussion: The results obtained are a correct tracking of the complete blink, the mean duration and the mean blink interval and standard deviation. The blink interval result is a little bit higher than a normal blink interval due to the activity monitored during the video recording in all cases and the patient's awareness of the characteristics being studied [4]. The algorithm is robust and easy to use. The memory needed to run the program is minimal because only the mean light value of each row of the eye frame is stored (27.8 minutes are needed for a one-minute video). Other applications and programs that tracks the blink are more complex and need more time and more resources to achieve the same goal.

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Evaluation of a blue blocker filter using eye-tracking technology

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Aim: With the increasing use of electronic devices and the possible effects of the blue light emitted by these devices on visual health, the main purpose of this article is to use an eye-tracking system to evaluate the differences in visual performance during reading with two ophthalmic lenses, each with its own absorption/reflection characteristics. We also seek to determine the differences, if any, in the pupil size and reading pattern associated with these filters and the spectral characteristics of the optotypes.

Experimental method: Twenty-five emmetropic or contact lens compensated subjects completed reading tests while using a standard coating and a filter which partially blocks wavelengths between 450-550 nm. Reading tests with different contrast and spectral characteristics were designed: 1) A high contrast optotype using black letters (RGB: 0-0-0) on a white background (RGB: 255-255-255) and 2) a low contrast optotype using blue letters (RGB: 45-144-198) on an orange background (RGB: 224-176-131)), combining colors affected by the blue blocker filter. Changes in the pupil size and reading pattern (reading time, number, and duration of fixations) were evaluated by an eye-tracker (TobiiPro Glasses 3) in three reading blocks (start-middle-end). For the statistical analysis, a multifactorial ANOVA test was used and a p value<0.05 was considered significant.

Results: Lens type significantly affected pupilar diameter, with larger pupilar diameter during reading with the blue blocker lens (p=0.002). The reading pattern did not show statistically significant differences between lenses (p>0.05). Spectral characteristics of the texts and reading blocks produced statistically significant differences on the pupil diameter and reading pattern. The optotype

with the blue/orange combination provided a higher pupil diameter, less fixations and higher fixation duration. Regarding reading blocks, at the end of the reading pupil diameter decreases, reading time and total fixations were higher and fixation duration was lower. Figure 1 shows the means and standard deviation for each variable.

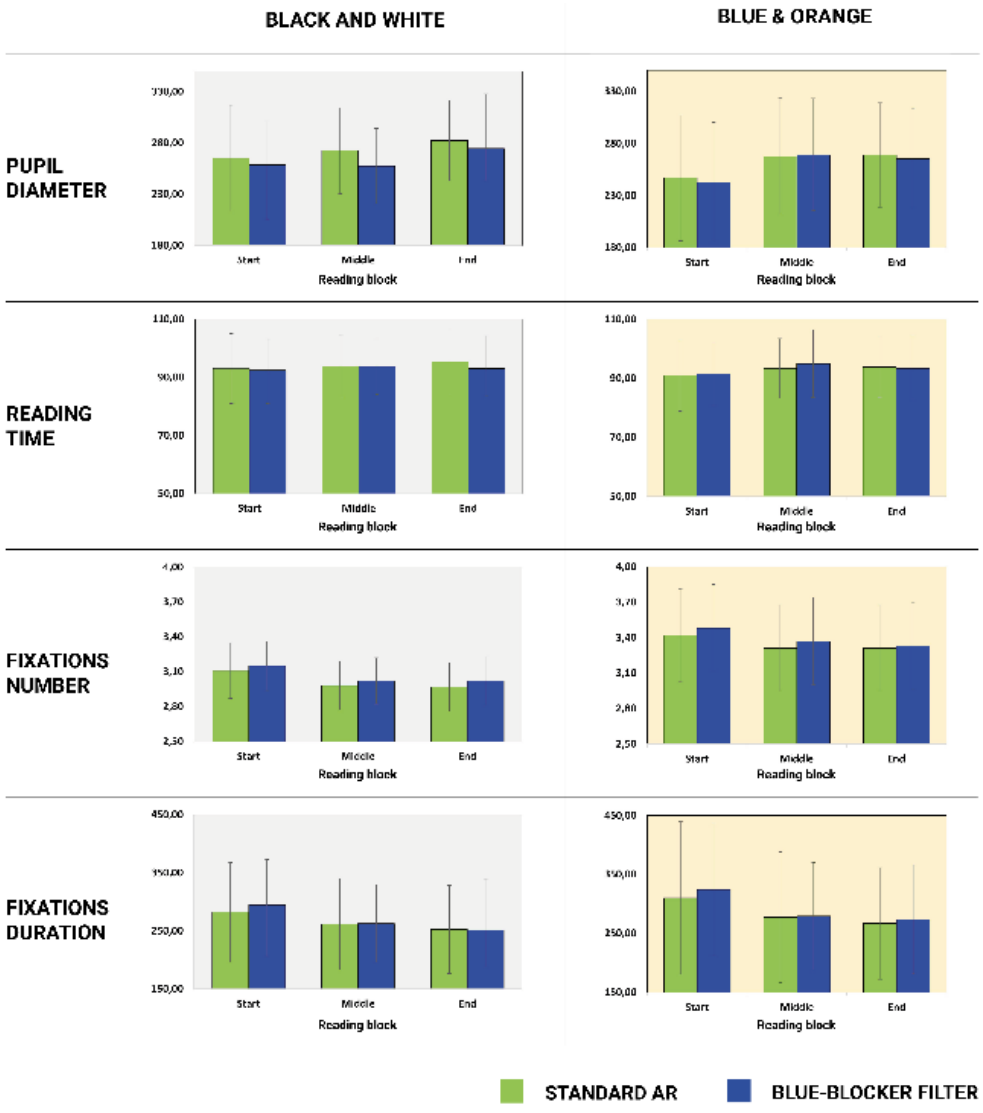

FIGURE 1. **A)** Pupil diameter, **B)** Reading time, **C)** Fixation number, **D)** Fixation duration.

Discussion: As in the study by Wentz&Winter [1], our study did not show statistically significant differences in eye movements when reading with the blue-blocker filter. An associated increase in pupil diameter with this filter was observed, probably due to transmittance reduction. The study published by Ostrin [2] concluded that a decrease in pupil diameter is produced after an adaptation period to these types of filters. Hence, in future studies it would be interesting to evaluate if the increment observed in our study regarding pupil diameter varies after an adaptation period.

Conclusions: The evaluation by an eye-tracking system of pupil diameter and reading pattern helps to evaluate changes in visual performance during reading between different types of ophthalmic lenses. It was verified that a lens with a multilayer coating consisting of a filter that partially blocks blue light increases the average pupilar diameter during reading due to an overall reduction of the lens transmittance. However, it does not produce variations on reading time, number or the duration of fixations.

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2.5. BINOCULAR VISION

Comparison of horizontal heterophoria values in reading and computer tasks in an adult population

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Aim: The purpose of this article is to determine the differences between the normal values of horizontal heterophoria at reading distance (40 cm) and the distance of computer use (60 cm) in a non-presbyopic population.

Experimental method: Forty-one asymptomatic subjects (22 females and 19 males; age range 18 to 30 years) initially participated in this study. They were emmetropic or ametropic, not exceeding ± 2D sphere or ± 1D cylinder. This study excluded contact lens wearers and subjects who had undergone refractive surgery or had any systemic or ocular disease. They also should not have had binocular and accommodative anomalies [1, 3]. The Von Graefe method was used for the assessment of horizontal heterophoria at 40 and 60 cm distance. Non-parametric tests (the Wilcoxon signed-rank test) were used to compare the results. P-value <0.05 was considered statistically significant.

Results: 48.7% was excluded from the study because they presented 40-cm horizontal deviations outside the criteria norms (0 to 6 Δ exo). In the remaining participants (20 subjects), the mean of the horizontal phoria at a distance of 40 cm was 2.8 ± 2 Δ Exo and at a distance of 60 cm, it was 1 ± 2,3 Δ Exo. A statistically significant difference was found between horizontal heterophoria measured at 40 cm and 60 cm (p= 0.004).

Discussion: This study shows that the normal criteria values of horizontal deviation at 40 cm should not be used to evaluate a subject with greater distances using a video display unit (VDU). Therefore, it is important to consider these as-

pects in the binocular vision examination of these patients. More studies are needed to determine normal values of binocular tests in VDU users.

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Influence of mobile phone distance on accommodative state

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Aim: The purpose of this article is to determine the relationship between working distance and accommodative LAG (accommodative delay) [1], taking into account the possible relationship between LAG and myopia. It also aims to evaluate the working distance in the office with respect to the usual distance in conditions of cell phone use.

Experimental method: Twenty-three subjects were recruited, 20 of whom undertook the study. The LAG was assessed using a dynamic NOTT retinoscopy at the distance indicated by the subject with their mobile device, three measurements of the working distance (Dt) and a dynamic NOTT retinoscopy were taken to later calculate the mean and standard deviation. Subsequently, an application was installed on their mobile device to evaluate the subject's usual distance under everyday conditions for 15 days.

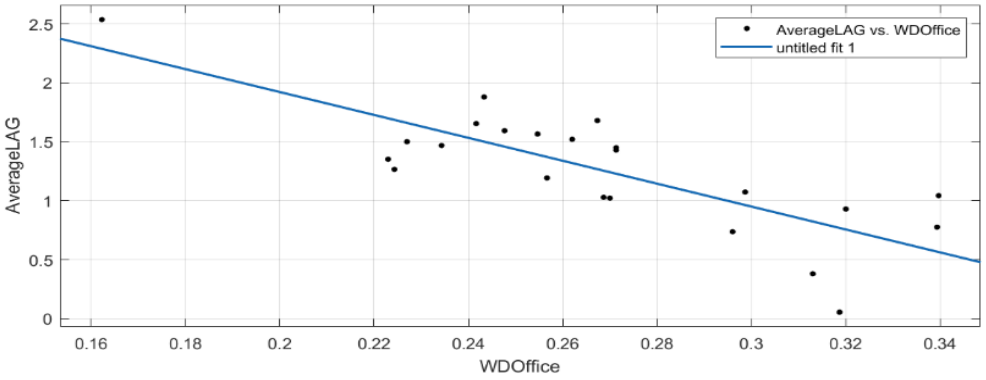

FIGURE 1. Fitted by lineal function.

Results: A correlation was observed between Dt (the mean and standard deviation was Dt 0.269m ± 0.041m) and LAG (1.278D ± 0.546 D), with a Pearson's correlation p=-0.795. There was no difference between Dt measured in the office (the aforementioned mean and standard deviation) and Dt measured by the app (Dt 0.249m ± 0.041m). In addition, there was no difference between myopes (1.26D±0.56D) and hyperopes (1.24D± 0.37) in LAG measurement. The p-value was greater than 0.05, so the null hypothesis was accepted, where it was shown that there were no differences in accommodative LAG between the two groups.

Discussion: It was observed that less working distance increases accommodative LAG [2, 3], as reported by other investigators. The distances measured in the office and with the application were not different. Finally, it should be noted that this study did not find a higher accommodative LAG in myopes than in hyperopes [4].

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Interexaminer repeatability and agreement in the measurement of ocular heterophoria in children

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Aim: The purpose of this article is to assess and characterize the evaluation of heterophoria with different tests in a sample of children in terms of repeatability in clinical practice.

Experimental method: Heterophoria in distance vision (at six meters) and near vision (40 cm) with test glasses was quantified in two sessions (1 week apart) in 96 subjects (men = 46, women = 50) with a mean age of 5.41 years and SD of 0.49 years. The ametropia range was from –0.25 to –2.00 D for myopia, from +0.25 to +5.75 D for hyperopia and up to –4.50 D for astigmatism. The three tests used were the Von Graefe, the Cover test for distance vision and the modified Von Graefe and Thorington cover test for near vision. The repeatability of the tests and the agreement between them was estimated using the Bland-Altman method, where the mean difference and the 95% limits of agreement were determined as the repeatability coefficient (RC).

Results: The RC in all the tests studied was better when performing the tests in far vision, compared to near vision. CR ranges were from ± 2.03 Δ to ± 3.33 Δ at distance and from ± 3.34 Δ to ±3.86 Δ at near. The Cover test showed the best repeatability in far vision (RC = ±2.03 Δ) and in near vision (RC = ±3.34 Δ) with a significant mean difference of –0.39 Δ (p=0.03).

Discussion: There are previous studies of inter-examiner repeatability of heterophoria, but not in children, so it is of interest to study how the tests that measure this variable behave in this group of subjects. [1-3].

Conclusions: Different repeatability coefficients were observed for each test, being worse when performing the tests in near vision. The Cover test was the most

reproducible test at both distance and near. The different tests studied showed different repeatability, so it is not recommended to use the tests interchangeably.

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The DEM test objectively monitored with eye-tracker in young people without binocular dysfunctions

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Aim: The purpose of this article is to use an eye-tracker to objectively measure the ocular motility parameters that intervene when performing the DEM test and to evaluate the coordination between both eyes in a sample of young subjects without visual dysfunctions.

Experimental method: An optometric evaluation was carried out on each of 52 participants, with a mean age of 21.00 ± 3.22 to verify that they would not have any binocular dysfunction. Then they completed a computerized version of the DEM test, while their eye movements were recorded by an eye-tracker (Tobii Pro Fusion, Tobii AB, Sweden). A new software program was developed to analyse some specific parameters of ocular motility while doing each sub-test (Test A, Test B and Test C) of the complete DEM test.

Results: The mean duration of saccades was longer in Test C (22.90 ± 2.70 s) than in Test A (15.94 ± 2.22 s) and Test B (16.10 ± 1.90 s), but it was the opposite in the mean duration of the fixations, with shorter duration in Test C (243.56 ± 46.18 s) than in Test A (493.52 ± 171.41 s) and Test B (484.20 ± 156.59 s). In terms of subtest duration, we can observe that the time to perform the first two tests was similar (Test A: 16.51 ± 2.83 s vs. Test B: 17.11 ± 2.85 s). The mean adjusted horizontal (AdjHT: 35.24 ± 6.68 s) and vertical (VT: 33.58 ± 5.56 s) time and the mean ratio (1.05 ±0.09) were calculated, considering the values of all the participants. The mean VT was in the 40th percentile and the AdjHT was in the 45th percentile. In Test C, there was a high positive significant correlation between the saccadic speed (cc: 0.77; $p < 0.001$) and the saccadic length (cc: 0.74; $p < 0.001$) of the right eye (RE) and the left eye (LE). There was also a statistically significant positive correlation (cc: 0.91; $p < 0.001$) between the RE and LE pupillary size.

Discussion: Comparing the specific data obtained thanks to the eye-tracker, both the speed and the amplitude of the horizontal saccadic movements of Test C are faster than the vertical ones of Test A and Test B. In addition, we performed more than twice as many saccades in Test C (186.66 ± 96.87) than in Test A or Test B (49.96 ± 41.95 and 53.20 ± 44.46). This may be due to the greater number of numbers and their arrangement in Test C.

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2.6. REHABILITATION, PERCEPTUAL TRAINING AND VISUAL THERAPY

Analysis of two methods of evaluating ocular motility using an eye-tracker

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Aim: The general objective of this study is to assess the ocular motility of young subjects using an eye-tracker through the King-Devick (KD) test and the Visual Tracing Test (VTT) and analyze the results obtained. The KD test is used to assess saccadic movements and the VTT is used to assess pursuits. Both are indirect psychometric measures of oculomotor performance used for the clinical assessment of eye movements. For this reason, the number, duration, amplitude and speed of fixations and saccades will be explored. The relationship between both ocular motility tests will also be studied.

Experimental method: Fifty-nine young volunteers who met the inclusion and exclusion criteria were selected. An optometric examination and a symptom questionnaire were performed to diagnose possible binocular and accommodative dysfunctions. Using an eye-tracker, ocular motility was assessed with the digital version of cards A, B and C of the KD test and five cards of the VTT. The experiment was performed under controlled photopic lighting conditions and with the patient positioned on a chin rest at a distance of 60 cm. The eye-tracker used in this study was the Tobii Pro Fusion (Tobii Technology AB, Danderyd, Sweden).

Results: After analyzing the data obtained, as the KD test progressed, the number of fixations, their duration, the duration of the saccades and the total duration of

the test increased. As the patients advanced in the performance of the VTT test, the number of fixations, saccades, the duration of the fixations and the total duration of the test increased while the amplitude of the saccades decreased. In both cases, this is because each card increased the difficulty of the test. There were relationships between various parameters of the two tests used. The relationship between the duration of the saccades of both tests and the average velocity of the saccades was direct. However, the relationship between the mean speed of the saccades in the VTT and the duration of the fixations in the KD test was inverse (Table 1).

Spearman's Rho	N=51	KD duration of fixations	KD duration of saccades	KD average amplitude	KD average speed
VTT duration of fixations	Correlation coefficient	0,473	0,206	-0,129	-0,191
	p-valor	0,000	0,147	0,368	0,180
VTT duration of saccades	Correlation coefficient	0,190	0,625	0,157	0,022
	p-valor	0,182	0,000	0,270	0,878
VTT average amplitude	Correlation coefficient	-0,297	-0,268	0,560	0,146
	p-valor	0,035	0,057	0,000	0,306
VTT average speed	Correlation coefficient	-0,467	-0,357	0,381	0,725
	p-valor	0,001	0,010	0,006	0,000

TABLE 1. The table shows the most remarkable correlations between the King-Devick (KD) and the Visual Tracing Test (VTT).

Discussion: The KD test is a visuo-verbal test commonly used in optometric consultations to assess ocular motility in children. In another study with an eye-tracker, a series of measurements were carried out in 61 volunteers between 19 and 25 years old to test the reliability of the KD test for the evaluation and monitoring of concussions. An eye-tracker was used to measure the time taken to complete each test, total saccadic movements, average saccadic velocity, total fixations, intersaccadic interval and average fixation polyarea. [1].

These results do not entirely agree with those obtained in our study, as the mean total saccadic movements in the second test did increase over the first. However, in the third test, they decreased again, while the number of fixations did increase as the test duration increased. The results for saccadic velocity also did not coincide with higher velocities in our study as the test duration increased. This may be because the studies by this author were carried out with professional athletes. Research has shown that standard training in a sport can increase visual skills [2]. Therefore, when performing an exercise that requires eye movements, they can perform it faster than non-athletes, such as the subjects included in this study, which were generally used in our research.

When comparing the results of this study with previous studies using the same tests, whether performed by an eye-tracker or manually, some discrepancies can be observed that may be due to the method used to measure the duration of each test or to the difference in age of the subjects analyzed. After carrying out this study, it can be said that the eye-tracker technique is an effective method for evaluating oculomotor movements.

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Improvement in fusional vergence amplitudes after a vision therapy protocol for subjects with typical binocular vision

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Aim: The goal of the study was to objectively evaluate the change in fusional vergence amplitudes at near distance in a group of adults with typical binocular and accommodative systems after performing 12 weeks of a conventional vision therapy protocol.

Methodology: A total of 32 adults (24±4 years) were randomly classified into an experimental group (EG) (N=16, 14 females) and a control group (CG) (N=16, 9 females). The office-based vision therapy protocol performed by the EG consisted of 12 weeks of 45 min/week of conventional vergence therapy. This vision therapy protocol was designed to train both positive and negative fusional vergence (PFV and NFV, respectively) amplitudes in the same proportion. The CG did 12 weeks of 15 min/week of office-based therapy based on eye movement exercises in the frontal plane. Participants' fusional vergence amplitudes were measured objectively before starting the vision therapy and at the end of the protocol. Both evaluations were done using an haploscopic set-up and eye movements were recorded with the Eyelink 1000 Plus (SR Research) eye-tracker at 500Hz. A column of 0.20 LogMAR letters presented at a viewing distance of 40 cm was used as a stimulus and its disparity changed smoothly at 1PD/s up to 45PD for both PFV and NFV. The break point was determined offline using a custom algorithm written in Matlab for analyzing the eye movements (Figure 1).

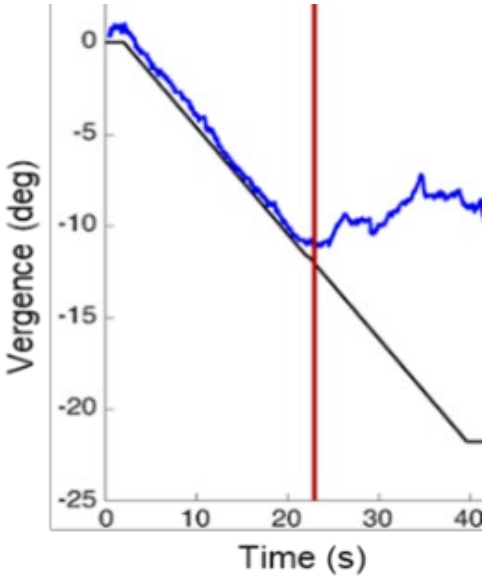

FIGURE 1. Example of vergence movements measured (in blue) during a NFV amplitude measure. The vergence demand driven by the stimuli is shown in black. The red vertical line represents the time of the objective break point.

Results: Before starting the vision therapy protocol, the two groups showed similar break points for PFV with a median (interquartile range) of 43.27 PD (15.51 PD) for the EG and 42.34 PD (19.02 PD) for the CG (Z= –0.93, p=0.353). After

the vision therapy protocol, the EG exhibited a statistically significant increase in PFV [break points of 45.00 PD (0.00 PD), Z= –2.52, p=0.012] and all participants reached maximum disparity, whereas it remained stable for the CG [44.33 PD (12.51 PD), Z=-0.94, p=0.347]. The NFV break points of the CG was 13.06 PD (3.62 PD) and 13.92 PD (6.37 PD) for the EG, so before starting the vision therapy protocol, they were not statistically significantly different (Z=-0.565, p=0.572). After the vision therapy protocol, there was no statistically significant change in the NFV break point for the CG (13.40 PD (6.26 PD) or the EG (14.62 PD (3.93 PD), Z=-1.34, p=0.178).

Discussion: Vision therapy is the most effective treatment option to increase the amplitude, speed, and accuracy of vergence responses and improve visual comfort [1]. It can also be used to prevent symptomatology related to the increased visual demands at near distance [2]. However, with conventional clinical methods, it is not possible to objectively quantify the effects of this treatment or to generate objective records to monitor the change in oculomotor performance over time. Eye-tracking systems can be used to objectively measure vergence responses and monitor the effects of vision therapy protocols objectively and accurately.

Conclusion: As expected, the CG showed no change in PFV and NFV amplitudes after a vision therapy protocol. After the conventional vision therapy protocol for the vergence system, the EG improved PFV amplitudes, but not NFV amplitudes. It may not be possible to further increase participants' NFV amplitudes with normal binocular vision if they already exhibited top performance at the physiological limit of divergence capabilities before the vision therapy protocol. More sessions might be needed to improve NFV amplitudes, as divergence is generally more difficult to train than convergence.

Financial support: This study is part of the project PID2020-112527RB-I00, funded by MCIN/AEI/10.13039/501100011033.

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Insufficiency of convergence: a case report

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Aim: The objective of this study is to present the clinical case of a 23-year-old patient with symptomatic convergence insufficiency, treated through a visual therapy program.

Experimental method: The patient reported headaches after prolonged study periods, near vision blurring and visual fatigue throughout the day. The symptomatology increased during the period of confinement. The patient presented daily headaches and prolonged visual fatigue due to increased exposure to the computer screen and tasks in near vision. Before the visual examination, the patient answered the CISS V-15 questionnaire.

Convergence insufficiency associated with accommodative excess was diagnosed, more pronounced in the left eye (LE). The patient presented emmetropia in both eyes. In the evaluation, an exophoria was obtained in near vision that was not compensated by its positive fusional vergences according to Sheard's criteria. The values of the tests that evaluate convergence were also reduced: near point of convergence, positive fusional vergences, vergence flexibility, binocular accommodative flexibility with positive lenses and negative relative accommodation (NRA). Regarding accommodation, accommodative excess was observed. The patient had more difficulty in relaxing accommodation during the monocular accommodative facility with positive lenses with the LE.

A visual therapy treatment was prescribed for 17 sessions, aiming to normalise the values of the accommodative and binocular tests and reduce the patient's symptoms. (Table 1).

Phase 1	Phase 2	Phase 3
- Accommodation - Motility - Anti-suppression - Vergences	- Accommodation - Anti-suppression - Vergences	- Accommodation - Anti-suppression - Vergences

TABLE 1. Vision therapy phases.

Results: The results of the optometric evaluations carried out before and after treatment with vision therapy and the normal ranges are shown in Table 2. After treatment, the values found in the different optometric tests were observably within normal limits.

	BEFORE			AFTER			NORMAL VALUES	
NPC	9/17 cm			< 3 cm			< 6 cm	
COVER TEST	12 Δ Exophoria			6 Δ Exophoria			1 Δ Exophoria	
MADDOX TEST	**FV:** 12ΔExo	**NV:** 18ΔExo		**FV:** 1.5ΔExo	**NV:** 6ΔExo		1 Δ Exophoria	
PFV	**FV:** 6/4	**NV:** 16/8		**FV:** 45/40	**NV:** >45		**FV:** 11/7	**NV:** 19/14
VF (4/14 Δ)	FV: 0 cpm	NV: 12 cpm		FV: 13 cpm	NV: 16 cpm		11 cpm	
AF	**RE:** 13 cpm	**LE:** 9 cpm	**BE:** 12 cpm	**RE:** 16 cpm	**LE:** 14 cpm	**BE:** 14 cpm	11 cpm	
NRA/PRA	+1.00 D/-2.50 D			+2.25 D/ >-3.00 D			+2.50 D/ -2.50 D	
MEM	+1.50 D BE			+0.75 D BE			+0.75 D	

TABLE 2. Pre-treatment and post-treatment subjective clinical measures and normal range. NPC: near point of convergence; LE: left eye; RE: right eye; BE: both eyes; CPM; cycles per minute; cm: centimeters; FV: far vision; NV: near vision; PFV: Positive fusional vergence; VF: Vergence Facility; AF: accommodative facility; NRA/PRA: negative relative accommodation/positive relative accommodation; D= diopters; MEM: monocular estimation method.

Discussion: One of the treatment options for accommodative and binocular vision dysfunctions is vision therapy [1]. This dysfunction is the most common. Many studies analyze vision therapy's effectiveness in treating convergence insufficiency. In a randomized clinical trial, Scheiman et al. improved the near point of convergence and positive fusional vergences after treatment of convergence insufficiency by VT and decreased symptoms [2]. A recent meta-analysis compared different types of treatment for convergence insufficiency; it concluded that office-based therapy with home reinforcement increases the chance of a successful outcome. However, the positive effect of the treatment was not so evident in the case of adults. Nevertheless, this case supports the effectiveness of vision therapy in adult patients. [3-5].

However, more research is needed on the efficacy of this treatment in the different accommodative and binocular vision dysfunctions.

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2.7. SPECIAL POPULATIONS

Primary congenital glaucoma: a clinical case

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Aim: To develop a clinical case of a patient with primary congenital glaucoma (PCG).

Experimental method: By means of a personal interview with the patient, the data referred to the anamnesis, the quality of life (QoL) and previous optometric/ophthalmological data were obtained, in addition to the data provided by ONCE.

The methodology for taking measurements was as follows:

- Visual acuity (VA) and subjective refraction with the Feinbloom test at 6 m; VA in decimal unit.
- Estimation of near VA with different glasses with high addition (24D; 28D; 32D) using the Lighthouse test for near vision at 7 cm.
- Corneal topography and wavefront aberration analysis with the Visionix VX 120+ measuring instrument.
- Fundus imaging with the Visuscam pro nm retinograph.
- Computerized campimetry using the MonCV3 campimeter.
- Slit lamp with camera for imaging.

Concerning the patient's QoL, the VFQ-25 questionnaire was completed [1-2]. It was read to the patient to facilitate its implementation. Afterwards, by means of a personal interview, the patient described how his vision has been throughout his life and how it has affected his QoL.

Results:

A. Visual parameters of the patient

Personal data: A 46-year-old man whose first diagnosis provided by ONCE was at the age of 8 years, in which he was diagnosed with PCG in the right eye (RE). This had an uncorrected visual acuity (UCVA)=0.01, best corrected visual acuity (BCVA)=0.1 and reduction of the peripheral visual field by 60%,

whereas the left eye (LE) was diagnosed with PCG and corneal degeneration (UCVA=BCVA=0.01).

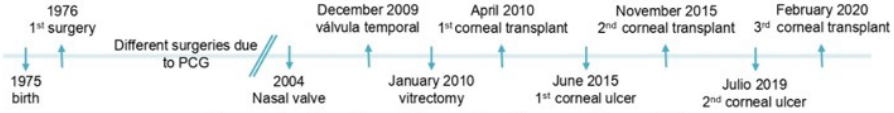

Figure 1.- Timeline of the patient´s operations, RE.

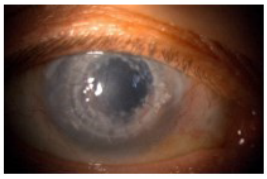

Figure 2.- Corneal condition, RE. The stitches from the last corneal transplant can be seen, these are not removed to avoid rejection.

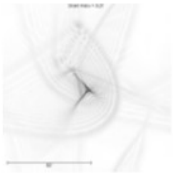

Figure 3.- PSF, RE. It can be seen an image produced from a point with so much distortion due to the patient's irregular astigmatism.

Medical history: The patient does not remember having vision with the LE and the timeline for the RE can be seen in Fig. 1. He is currently taking antiglaucomatous medication, immunosuppressants and corticosteroids to prevent rejection of the third corneal transplant and control IOP.

Measurements: He usually wears glasses with a prescription of (+8.00) (-4.00)100°and a near spectacle with high addition (+22D) for the RE. His UCVA (0.056) and BCVA (0.066) were taken. At near vision the patient had difficulty reading the near visual aquity (NVA)=1M(0.07 decimal); he wanted to read it to have autonomy as a father so he can read medicine leaflets. Retinoscopy of the RE was performed, obtaining (+6.00)(-4.00)70º and a topography where was observed a corneal cylinder of (-5.75)62º. In the subjective examination, (+6.50) (-6.00)65º was obtained, giving the patient a VA=0.1. It was decided to try three pairs of glasses with high additions for near vision. He performed best with the 28D glasses, reading NVA=1M. A slit lamp examination was performed (Fig. 2), as well as a fundus and a visual field examination, where we see superior visual field loss corresponding to the inferior eye fundus defect. Finally, a wavefront analysis was performed, highlighting its PSF (Fig. 3).

B. QoL of the patient

VFQ-25 test: A total score of 45.13 was obtained, where the general health and driving questions were omitted. The patient's general health score was 75.00 while the general vision score was 20.00 points. Notably, he scored high on mental health (81.25) and low on social function and peripheral vision (25.00).

Life experience: The patient reports how he can cope easily in all areas thanks to his experience, but he is also aware of his reduced vision. The only area

where the patient has encountered problems throughout his life has been in parenting and in socializing.

Discussion: During the clinical case, a slight improvement of VA was achieved despite the irregular astigmatism. The VFQ-25 scores were in accordance with his life experience and pathology.

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The effect of cataracts on individual biological rhythms

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Aim: Chronotypes are individual biological and behavioral rhythm characteristics that show preference as to a sleep-wake cycle. It is well established in many studies that morning types (M-type) show a marked preference for waking at an

early hour and going to bed early, while evening types (E-type) wake up late, stay out late and tend to be more exposed to artificial bright light [1].

This study aims to assess whether cataracts have an impact on the individual's chronotype (i.e., morningness versus eveningness).

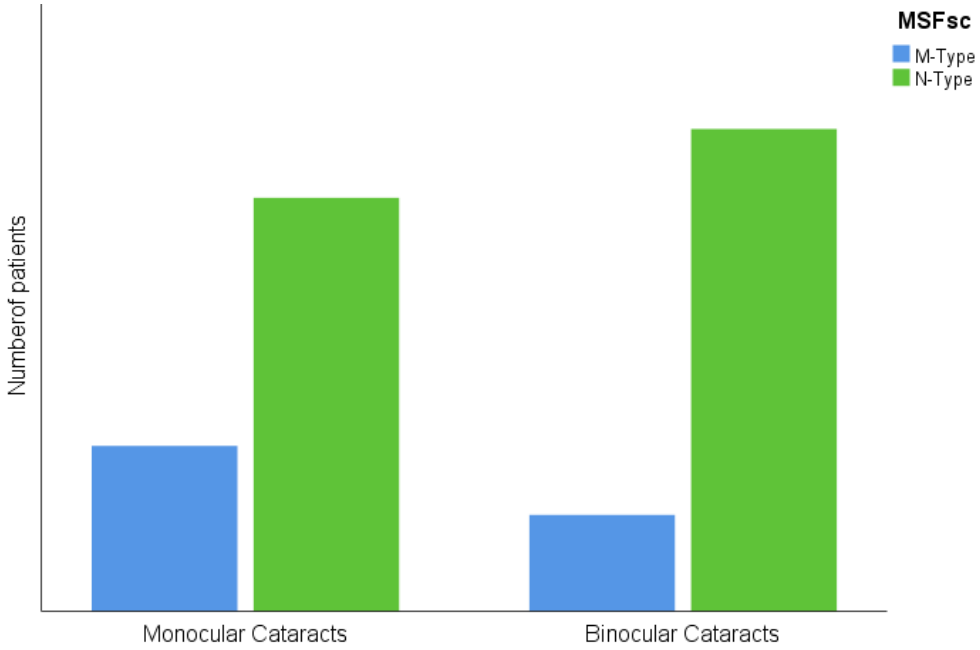

FIGURE 1. Chronotype in a population with cataracts.

Experimental method: A Munich Chronotype Questionnaire (MCTQ) [2] was conducted for patients diagnosed with binocular cataracts (n=42) and monocular cataracts (n=42). A total of 84 patients (46 men and 38 women, 74.6 ± 6.7 years of age), all residents of Valencia, Spain, were recruited for a descriptive, observational, prospective and cross-sectional study.

Chronotypes were given by mid-sleep on free days corrected for sleep deficit (MSFsc). MCTQ parameters were represented by hours. The range of scoring was from 1 to 7.5. The participants scoring between 1 to 3.5 were considered M-types, those scoring between 3.6 to 5.5 were seen as neither types and those scoring between 5.6 to 7.5 were classified as E-types.

The mean and standard deviations were computed and the normality of the samples checked with the Shapiro-Wilk test. A statistical comparison between groups was performed with Student's t-test. The statistical test used for qualitative variables was Pearson's chi-squared test ($\chi 2$) in both binocular ($\chi 2b$) and monocular cataracts ($\chi 2m$).

Results: Morningness was more frequent in men than women in both groups, but the difference was not statistically significant (χ2b=0.968, p=0.325 vs. χ2m=0.902, p= 0.342). There was no significant relationship between chronotype and age (≤ 65 years group and >65 years group).

(χ2b =2.291, p=0.130 vs. χ2m=0.000, p= 1.0).

Using Student's t-test, we found that differences in chronotype were not significant due to binocular or monocular cataracts (t=-0.713(82), p=0.478), although in patients with monocular cataracts morningness was more frequent (27%) than in those who have binocular cataracts (19%). There were not eveningness patients in both groups (Figure 1).

Discussion: Although there was a tendency for morningness in patients with monocular cataracts against patients with binocular cataracts, especially men more than women, no significant differences were found. Overall, chronotype changes with advancing age towards a more M-type orientation [3] but not in our study, which was formed by a special population with advanced cataracts. According to the results reported by Lehnkering et al [4], sleep factors of the elderly may also depend on their lifestyle.

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Unilateral adult-onset foveomacular vitelliform dystrophy: a case report

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Aim: To report a case of unilateral adult-onset vitelliform macular dystrophy in a patient with years of follow-up.

Experimental method: Case report of a 75-year-old woman diagnosed with unilateral adult-onset vitelliform macular dystrophy seven years ago. A complete ophthalmological examination was performed, including visual acuity with the ETDRS optotype (Precision Vision, Illinois, USA), optical coherence tomography with Spectralis SD-OCT (Heidelberg Engineering software version 6.0.11.0, Heidelberg, Germany), ultra-widefield autofluorescence imaging with Optomap (Optos PLC, UK) and a biomicroscopy examination. Her prior ocular history includes three Bevacizumab injections in another center, the last in March 2015. The patient was treated in our center with one Bevacizumab injection in October and one Aflibercept injection in November 2015 due to retinal neovascularization. There has been no treatment since. In the follow-up on the patient, it was possible to observe the different stages of the pathology.

Results: The patient reported a slow and gradual loss of visual acuity and metamorphopsia for years in the right eye (table 1). Visual acuity in the right eye was 0.7 logMAR and in the left eye it was 0.1 logMAR. The OCT of the right eye showed a central area of retinal epithelial atrophy consistent with end-stage adult-onset vitelliform macular dystrophy. Autofluorescence showed the delimitation of the lesion in the right eye and an atrophic lesion without central autofluorescence was observed (approximately the size of half a disc diameter with a heterogeneous appearance). The left eye was normal.

Discussion: Adult vitelliform dystrophy is usually a bilateral pathology [1], although some unilateral cases have been described (such as ours). It is characterized by subfoveal rounded yellowish lesions and a loss of visual acuity and its clinical characteristics can be confused with other pathologies such as Best's dystrophy or macular degeneration [2, 3], so it is important to establish a correct differential diagnosis. OCT has proven to be a useful diagnostic tool for this pathology [3, 4] and furthermore, with the continuous evolution of technology,

other tools such as ultra-widefield autofluorescence imaging facilitate the diagnosis of the pathology and improve its follow-up.

Visual acuity far vision without correction (LogMAR)		
	Right eye	Left eye
16/09/2015	0.7 PH 0.4	0
01/10/2015	Bevacizumab	-
18/11/2015	0.4 PH 0.2	0
19/11/2015	Aflibercept	-
15/01/2016	0.4 PH 0.2	0
09/06/2016	0.4 PH 0.3	0
28/09/2016	0.3 PH 0.2	0
28/06/2017	0.4 PH 0.3	0
09/10/2018	0.7 PH 0.6	0.1 PH 0.1
16/04/2019	0.8 PH 0.6	0.1 PH 0.1
28/10/2021	0.7 PH 0.7	0.1 PH 0.1
28/04/2022	0.7 PH 0.7	0.1 PH 0.1

TABLE 1. LogMAR visual acuity in the different visits. PH: pinhole.

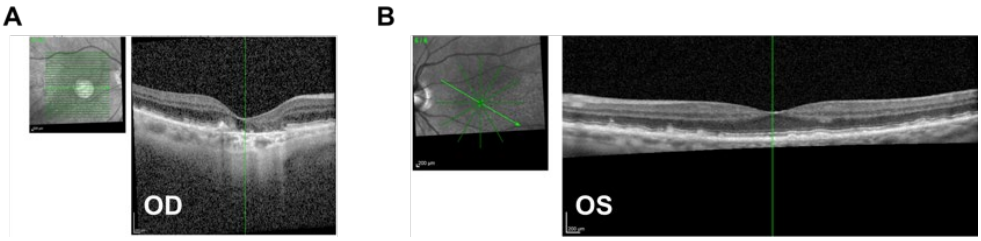

FIGURE 1. **A)** Optical coherence tomography (OCT) at the last visit. OD: final stage of adult vitelliform dystrophy (atrophy stage). **B)** Small drusen in the outer layers of the retina. Preserved foveal profile. OD: right eye; OS: left eye.

Conclusion: It is important to know the signs and symptoms of adult vitelliform dystrophy and perform a complete examination to establish a correct diagnosis and follow-up because this pathology can cause low vision.

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2.8. VISUAL PERCEPTION AND PROCESSING

Color vision in neurodegenerative diseases, bibliographic review

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Aim: Neurodegenerative patients may suffer different visual alterations during the disease. Some studies have suggested chromatic dysfunction as a possible marker of neuropathology. The goal of this study was to compile a bibliographic review about recent studies that investigate the relationship between different neurodegenerative diseases (Alzheimer's, Parkinson's, Multiple Sclerosis, Schizophrenia, Bipolar Disorder and Epilepsy) and color vision alterations.

Experimental method: To carry out this bibliographic review, Goggle Scholar and Pubmed were consulted between September 2020 and March 2021.

The terms used in the search in the databases were: color vision, colour vision, neurodegenerative disease, Alzheimer, Parkinson, Multiple Sclerosis, Schizophrenia, Bipolar Disorder and Epilepsy. All diseases separately (Alzheimer's, Parkinson's, Multiple Sclerosis, Schizophrenia, Bipolar Disorder, Epilepsy) were combined with the terms "color vision" and "colour vision", joined by the Boolean operator "AND".

The studies had to be written between January 2000 and March 2021. Over 100,000 articles were obtained from this search between the two databases.

Once the previous search was done, the articles were filtered. Articles were chosen if they made with humans, if the documents included all search terms and if the studies used color tests such as the Ishihara Test or some type of Farnsworth-Munsell. Articles were discarded if the documents were published before the year 2000, the studies were not carried out in humans, the articles mentioned other neurodegenerative diseases than those chosen for the review, the articles dealt the diseases but not the chromatic alterations or they were studies with color tests created by the editors.

Of these articles, after applying the inclusion criteria and the exclusion criteria mentioned, 29 were selected for the discussion in this article.

Results: The articles compared the results obtained in color tests (Farnsworth-Munsell 100-Hue, Farnsworth-Munsell D-15, Lanthony D-15, Ishihara, Trivector, Ellipse, PV-16) of control subjects with a group suffering from a specific neurodegenerative disease.

The articles selected on color vision related to neurodegenerative diseases were: 6 on Alzheimer's disease, 6 on Parkinson's disease, 6 on Multiple Sclerosis, 4 on Schizophrenia, 2 on Bipolar Disorder and the remaining 5 on Epilepsy.

Discussion: There is a relationship between the progression of neurodegenerative diseases and color vision alterations, but it is not known what happens in each disease. In each of the neurodegenerative diseases, a specific color range is affected [1-6].

In Parkinson's and Alzheimer's patients, the blue-yellow and red-green axes were affected. In patients with Multiple Sclerosis, the red-green axis was altered and the blue-yellow axis could also be affected. Schizophrenia patients had all colors affected, but none was completely affected. Patients with Bipolar Disorder presented a slight protanomaly. And in the case of Epilepsy, only blue was affected because the medication disturbed the cones responsible for perceiving this color.

Moreover, there are few color tests that analyze all color range in detail and the tests that do are complicated for most of these patients.

With the research that exists to date, color alterations cannot be taken as early biomarkers of neurodegenerative disease. The color test can be useful to differentiate between patients and healthy subjects, but not to detect the disease earlier or to differentiate between neurodegenerative diseases.

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2.9. OTHER OPTOMETRY-RELATED SUBJECTS

Correlation between functional and structural assessments of the retinal macula in healthy young subjects

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Aim: To evaluate the correlation between functional eye examinations (Humphrey 10-2 computerized campimetry) and structural measurements of the macula (Optical Coherence Tomography: OCT) in healthy young patients.

Experimental method: This study includes data from 60 eyes belonging to 30 healthy subjects between 18 and 25 years old with a mean age of 22.3 ± 1.34. Seventy percent were women and the remaining 30% were men. The health of the subjects was assessed by means of a previous anamnesis and visual acuity measurement. Subjects with any type of refractive condition were accepted if their monocular visual acuity (VA) in distance vision (DV) was at least 1.0 on a decimal scale. A Topcon TRK-2P autorefractometer was used to obtain the objective measurement of refractive error. Total retinal, nerve fiber layer (RNFL) and ganglion cell layer (GCL) thickness in the macular area were assessed by Topcon 3D OCT-2000 with two evaluation protocols, Radial and 3D Macula V. Retinal macular sensitivity was measured by Humphrey 10-2 computerized campimetry of the Zeiss Humphrey 745, obtaining the mean deviation (MD). All data collected have normal distribution. Pearson's correlation coefficient and the probability value (p) were used to evaluate the degree of linear dependence between two quantitative variables.

Results: A statistically significant positive correlation was found between the thickness of the GCL and MD (p=0.014; r=0.317) (Figure 1) in addition to dif-

ferent correlations between the variables studied. The correlation was not statistically significant between the thickness of the RNFL and MD (p=0.594), nor between total retinal thickness and MD (p=0.342).

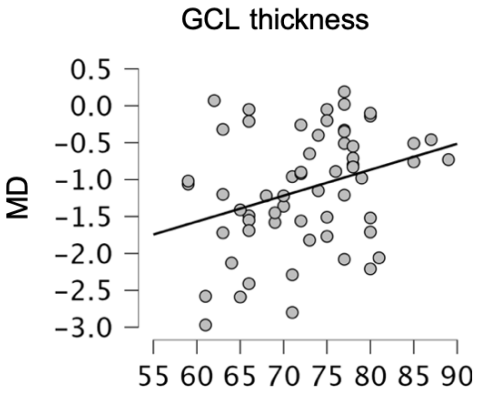

FIGURE 1. Graphical representation of the correlation between GCL thickness (μm) and MD (dB) in the macular area.

Discussion: The results confirm the hypothesis based on previous studies [1-2] of the existence of a statistically significant correlation between GCL thickness in the macular area and MD of Humphrey 10-2 automated campimetry in healthy young patients.

In this study, no statistically significant correlation is found between RNFL thickness and MD, which is supported by previous studies [3]; however, there are others that do find a correlation [1]. The correlation between the two parameters is controversial and future studies are required to better understand it.

The existing limitations of the study, such as the evaluation of both eyes in the statistical correlations, which does not obtain the same results as taking only one of them, are kept in mind for future research.

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Effect of power and astigmatism axis on visual acuity

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Aim: The purpose of this article is to investigate the change in visual acuity (VA) produced by simple myopic astigmatism of different magnitudes and orientations in young patients. [1.2].

Experimental method: An induced defocus method was used to simulate 24 defocus conditions in 21 patients with a mean age of 21.7±2.4. Using positive cylindrical lenses (+1D, +2D. +3D) oriented at different axes (0º, 30º, 45º, 60º, 90º, 120º, 135º, 150º), simple myopic astigmatism was induced in 21 healthy emmetropic patients. In each case, VA was measured using an ETDRS device and the results were expressed in LogMAR units. The results obtained for each combination were compared to assess changes in VA as a function of orientation and power of the induced astigmatism. The results obtained were also used to calculate the mean degree of astigmatic defocus resulting from each of the combinations tested.

Results: No statistically significant differences in VA were found when changing the cylinder orientation. However, significant differences were found when changing the magnitude of the astigmatism, with lower VA values obtained at higher induced dioptric defocus [3, 4, 5]. The mean values of VALogMAR obtained for each orientation, keeping the cylinder, constant were: For 1D: (0º: 0.13, 30º:0.14, 45º:0.16, 60º:0.16, 90º:0.14, 120º:0.14, 135º:0.16, 150º:0.14). For 2D: (0º: 0.4, 30º:0.4, 45º:0.48, 60º:0.48, 90º:0.44, 120º:0.41, 135º:0.40, 150º:0.47). For 3D: (0º: 0.63, 30º:0.65, 45º:0.69, 60º:0.68, 90º:0.65, 120º:0.69, 135º:0.69, 150º:0.66).

It was also found that the mean astigmatic defocus calculated for the mean of VA obtained in each combination was lower at high powers and higher at low and medium powers, alternating according to the cylinder orientation [6].

Discussion: In the statistical analysis, no statistically significant differences were found between the results obtained for astigmatisms of equal magnitude but different orientation. This is rather curious, since the literature indicates that the tolerance to the axis decreases the higher the power [3, 5, 6]. It also confirms Raasch's hypothesis [5] that the axis of astigmatism has no influence on VA. It further confirms the results obtained in the study by Tan et al [3] that indicated that the image quality was significantly degraded for astigmatisms greater than –0.75D, but this was independent of the axis. These changes in the results may be due to methodological differences, regarding how the astigmatism is simulated or how the parameters were taken into account when measuring VA.

Moreover, statistically significant differences were found for different cylinder powers oriented on the same axis and the results obtained show that the higher the MSA, the worse the VA obtained. These results are in agreement with the literature [1, 2, 4, 6].

Therefore, the present study makes it possible to conclude that for the sample studied, no subjective differences can be seen when changing the orientation of the axis for the same power, but visual quality does decrease as power increases, decreasing VA. This indicates that VA is better the closer the foci are to the retina, but it is also independent of axis orientation. This expresses that the tolerance effects towards the astigmatism-compensating lens are more dependent on the power than on the orientation of the lens.

Even so, the results obtained belong to a limited sample, so the conclusions are not applicable to the whole population.

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Headache and ametropia

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Aim: In the third edition of the international classification of headache disorders, carried out in 2018, it was determined that there is a headache attributable to refractive errors [1]. The purpose of this study is to analyze the most current scientific evidence to understand the relationship between headache and uncorrected ametropia, so that it can serve as a guide for optometrists in their daily clinical practice when prescribing graduations with the intention of reducing or eliminating these headaches.

Experimental method: A bibliographic review of studies published since 2014 on the subject to be discussed has been carried out, discarding those that showed a clearly deficient methodology.

Results: Headaches associated with refractive errors would be daily [2], mainly frontal [3, 4, 5], and would be accentuated as the day goes by [4]. The refractive errors most associated with headaches would be astigmatism [4-6], hyperopia [7] and anisometropia [5].

Discussion: Headaches and refractive errors are frequently associated, since both conditions are relatively common in the general population. Visiting optometrists with the main complaint of headache but without a complaint of poor vision is very common. However, there is no clear scientific evidence that demonstrates without a doubt the absence or presence of a relationship between headache and uncorrected ametropia. Standardized protocols are needed to con-

duct studies on headaches associated with uncorrected ametropia. It is also necessary to carry out clinical trials to assess the efficacy of the correction of the refractive error on improving the headaches, which would ultimately demonstrate the presence or absence of a causal relationship between these two variables. The task of the optometrist would be to detect those cases of headache whose characteristics indicate that it could be associated with an uncorrected refractive error and carry out a thorough visual examination to detect and correct this ametropia.

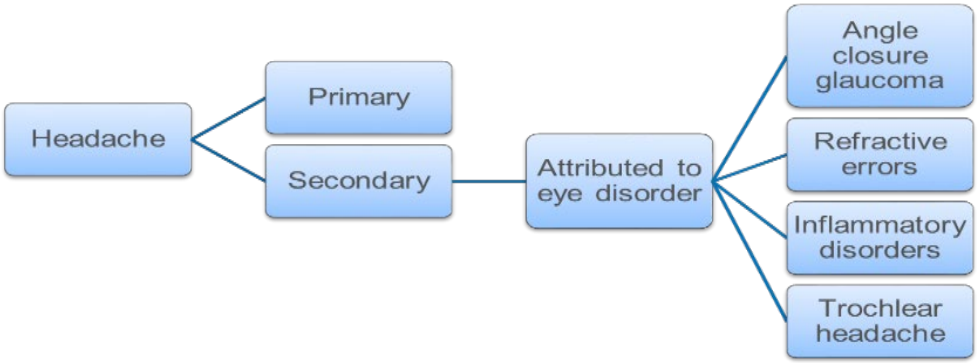

FIGURE 1. Types of headaches attributable to eye disorders, according to the international classification of headache disorders. Author's creation.

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Relationship between the results of the ocular surface disease index and the objective values of the ocular protection index with and without the use of an FFP2 face mask

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Aim: The purpose of this study was to assess how the use of valveless FFP2 face masks affects tear film stability in subjects not previously diagnosed with dry eye syndrome (DED). The Ocular Protection Index (OPI) with and without a face mask and the OSDI (Ocular Surface Disease Index) score were evaluated.

Experimental method: A study was conducted that included 35 subjects between the ages of 20 and 34 who used a face mask for a minimum of 6 hours a day. The OSDI test was performed to assess the existence of DED symptoms. Tear stability was recorded using a Topcon model CA-800 topographer, which measures non-invasive tear break-up time (NIBUT) and inter-blink interval (IBI) and calculates OPI. Two measurements were made: one with a face mask and one without it. A first analysis of the tear film was carried out on the total sample, which was subsequently divided into two groups: group A (subjects in which abnormalities of the tear film are observed after blinking qualitatively by the topographer) and group B (subjects in which these abnormalities are not observed).

Results: No significant difference was found neither for OPI nor for NIBUT with and without a face mask for the total sample. Regarding the results obtained from the OSDI test and the OPI, there is no linear association. For group A, both NIBUT and OPI were significantly higher with the use of a face mask than without it (NIBUT: p=0.026, OPI: p=0.019). And, for group B, NIBUT and OPI were significantly lower with the use of a face mask than without it (NIBUT: p=0.001, OPI: p=0.001).

Conclusion: The relationship between the OPI and the OSDI scores is not linear, so signs and symptoms should always be evaluated to diagnose DED. On the other hand, the use of face masks affects tear stabilities differently in subjects with and without different tear anomalies. The nature of these abnormalities needs to be studied and taken into account in future research.

ReMedy: a mobile application for a better use of medication and contact lenses

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Aim: The purpose of this article is to develop a user-friendly app to improve the effectiveness of medical treatments and the correct use of antibiotics by making their posology more accurate, including an informative extension for the correct use and storage of contact lenses.

Experimental method: We have designed a mobile application with a straightforward and intuitive interface (Figure 1) so users of all ages could use it easily,

with useful gadgets such as daily dose reminders and information about diet components that should be avoided while taking their medications and interactions with other pills.

In the contact lens section, we decided to set up automatic reminders that tell the user when they should be taken off and provide instructions on how to keep them and their case clean and when they should be replaced.

These explanations are supported by informative videos. This data is based on information provided by the Spanish Agency of Medicines and Medical Devices [1]. A total of 15,315 medicines is included in the app and described in the database.

FIGURE 1. Preview of the app interface.

Results: While this application is still under construction, we rely on the database of all legally regulated pharmaceutical drugs in Spain along with different types of contact lenses that operate in the country. We extract use recommendations for each type of contracted contact lens directly from the manufacturer. [2] This project has currently encouraged teamwork and enhanced our problem-solving skills; each team member was able to learn and utilize knowledge of the rest, putting it to use in the function of the project. For instance, biotechnology students were able to apply their knowledge to design an information format for every pill. Our engineer designed the interface prototype according to our desired characteristics. Our optometry student was responsible of defining the needs of the population that uses contact lenses.

Discussion: In further updates, we would like to add more features, namely the ability to add medicines or contact lenses to the interface by using its barcode, further differentiating it from the rest of the applications available to the public. This mobile application was a finalist in the MOTIVEM contest of 2022, organized by the University of Valencia, [3] making it a benchmark for students and faculty.

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2.10. TEACHING INNOVATION

Game-based learning as reinforcement tool in optic and optometry studies

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Aim: The purpose of this article is to develop a game-based learning tool to allow optometry students to understand the perception of patients with congenital color vision defects and contrast sensitivity losses and the design of psychophysical tests for detecting these visual problems.

Experimental method: Gamification is a learning technique based on the use of game mechanics in non-game contexts [1]. Its application as a teaching and learning tool has given rise to game-based learning (GBL) [2]. These methodologies aim to increase student motivation and to maintain the student's interest. Educators agree that they have positive effects on students [3].

Our GBL tool was designed with RPGMAKER MZ®, a program allowing not-advanced users to create games with an 8-bit aesthetic. The code simulates

two lab experiments from the practicum of the subject "Clinical Examination Methods" (CEM) in the Optics and Optometry degree program. The game's environment reproduces the Burjassot campus of the University of Valencia and students have to configure their avatar and navigate from the campus entrance to the first-floor lab in the Faculty of Physics where CEM is usually taught, select a free computer, choose the subject and select one of the two available experiments.

The first experiment focuses on the analysis of dichromatic color vision by means of a computerized color-ordering test based on the D15 color test [4]. The second experiment simulates the perception of patients with spatial and color vision defects. Both experiments can be carried out using Matlab-based software included in the CEM course's material. However, the difficulties of coping with the Matlab software interfere with the final goal, to understand the variant vision. The app aims to help users to overcome these problems by including activities that 1) help the student with the use of the Matlab software, 2) focus on the main results of the experiment and 3) train the student to analyze simulations of variant vision and vision tests results. Feedback to wrong answers explains errors in detail and elaborate images are included that allow the student to better understand the concepts. Questions about clinical diagnosis are included to show the student different visual pathologies from a simulated image.

FIGURE 1. Game screenshots. The first experiment (left) tests the student's knowledge of dichromatic perception. The second experiment (right) evaluates how losses in the spatial frequency domain affect stimulus perception.

Results: In a preliminary study, the game was played by 12 users who underwent a subsequent satisfaction survey to assess the app's usability by a scale of 0-10. Demographic data show that most users were female health science students between 22-24 years old. The users had knowledge about videogames and often

played games. Scores were high, with 8.6 for overall satisfaction. The items evaluating the controls, the realism of the game and its originality had mean scores of 8.2, 7.75 and 9.6, respectively. Although the duration scored only 4.6, the users stated that the time investment was good. The entertainment degree and the teaching experience scored 8 and 9, respectively. The users were willing to use the app again (score 8.75).

Discussion: The use of GBL provides students with tools for problem solving. The aim is not to perform the experiments. The app gives feedback to students about their errors to correct badly acquired knowledge. The results of the preliminary survey show that the software is usable and educational, although more exercises and lab simulations should be added in the future.

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A study of the applicability of the MUC test for teaching purposes using not colorimetrically characterized devices

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Aim: The study of chromaticity thresholds in the Optics and Optometry curriculum is important as a tool to obtain information about the properties of the chromatic mechanisms of the normal visual system [1] and as a tool to detect, quantify and classify congenital and acquired color vision defects [1]. A Matlab-based software program has been designed for use in academic labs with low-cost colorimetrically characterized 8-bit graphic cards [2]. In this paper, we analyze whether the software can be used by students as tool for study in their own computers using generic colorimetric characterization data despite the inherent color reproduction errors.

Experimental method: Fifteen patients took part in the experiment using the CVSimulator app [3] in their own phone to simulate congenital color vision defects, with the brightness set at half the device's range. Three different computers were compared. The chromatic thresholds were measured with the MUC software for Matlab [2] in a scene of 128x128 pixels with a C of Landolt, randomly oriented, whose color differs from the background along 11 different directions. The patient must indicate the letter's orientation or signal that the aperture cannot be seen. Optotip dimensions are 0.5° and 0.75° for the internal and external radius, respectively, and a 15° aperture. The background is achromatic (CIE1931 chromaticity coordinates x=0.32, y=0.326 and luminance 35 cd/m2). The distance between patients with normal vision and the different gadgets was adapted to keep the background's angular size at 10º. When simulating pathologies, the relevant distance is between the computer and the phone, unlike before, when it was between the computer and the patient. Patients rested for five min-

utes between measurements to avoid fatigue effects. The thresholds were obtained with the modified binary search method (MOBS) [4] and adjusted by an ellipse. Friedman's test with a post-hoc Bonferroni correction was used to test for differences between devices and normal and anomalous subjects, given that the Lilliefors normality test shows that the data (ellipse area and orientation) are not normally distributed ($p<0.05$).

Results: An analysis of interquartile ranges and a 95% confidence interval of the medians shows that regardless of the monitor, normal patients have smaller ellipse areas compared to the patients with simulated defects. The ellipse's orientation of normal and tritan patients are similar and differ from protan and deutan patients. However, a large and unexpected overlap between the orientation of normals and protans is observed in some devices.

Friedman's test detected statistically significant differences ($p<0.05$) between monitors for ellipse area and orientation. The post-hoc Bonferroni analysis showed significantly small areas for normals in comparison with anomalous patients in monitors 2 and 3, but in Computer 1, normals did not differ from protans, despite the larger median for the protan group.

The post-hoc reveals significant differences in orientation between the red-green defectives and normal and tritans, and no differences between normals and tritans, and between protan and deutan, but they remain different at the same time.

Discussion: The study shows that students may reproduce the expected results regarding size and orientation of normal and anomalous ellipses with non-colorimetrically characterized screens. However, it has been noticed that simulated defects affect discrimination along both the red-green and blue-yellow directions. Particularly in simulated protans, the real thresholds along the red-green direction lie outside the range of generable colors and cannot be determined. In these cases, when thresholds along the blue-yellow direction are also large, it is not reliable to determine the ellipses axis and data may even be fitted by a circumference. Data obtained with the different screens used in the study show significant correlation, but not concordance, so in a variety of brands and models used, the differences in displayed colors affect the result.

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The Sixth International Symposium of Young Optometrists (SIYO 2022) took place from 14 to 28 November 2022 in its usual online format. This conference aims to create a space featuring young optometry students and optometry practitioners.

This book of proceedings contains the abstracts of the different contributions to the conference. Its contents are organized into two sections: invited and sponsored talks and workshops, and free communications. This last section is divided in talks and poster communications, comprising the conference's different thematic areas.

The Organizing Committee thanks all the young and senior researchers who have contributed their work to the conference, the members of the Scientific Committee for their careful review of the work and the different companies and academic or official entities that have sponsored this event.

The Organizing Committee

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