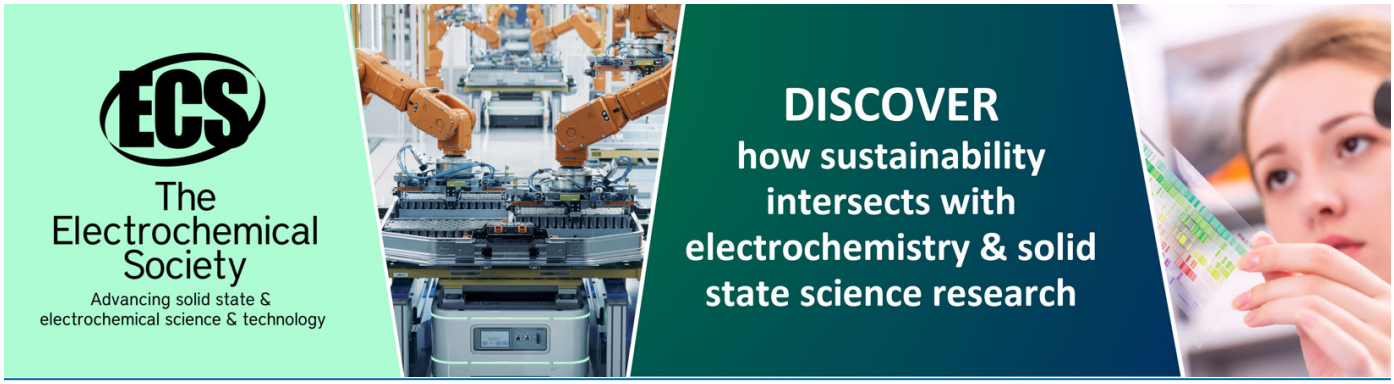
Comparison between central corneal thickness, anterior chamber depth and axial length values with and without contact lenses



Comparison between central corneal thickness, anterior chamber depth and axial length values with and without contact lenses

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Abstract. Purpose: To compare the values of central corneal thickness (CCT), the anterior chamber depth (ACD) and the axial length (AL) on measurements performed with and without contact lenses (CL) in healthy subjects. ACD was measured with two different devices (Visionix 120+ and EchoScan US-800) and the values were also compared between them. Material and methods: 20 volunteer participants (6 men and 14 women, 24.8 ± 2.73 years) were recruited. In a single visit, participants underwent autorefraction, biometry, topography and pachymetry with the naked eye (without CL). Then, biometry and pachymetry were repeated twice wearing two different CL (Somofilcon A and Nesofilcon A) of -3.00D lens power fitted in random order. Data were compared using t-tests for related samples. Results: CCT values wearing CL were significantly higher than those obtained with the naked eye (Paired t-test; both $p \leq 0.001$). On the other hand, no significant differences were found between the ACD or AL values with the naked eye versus any of the CL studied (Paired t-test, all $p \geq 0.111$). The ACD values comparing Visionix120+ to EchoScan US-800 measurements were significantly different with both the naked eye and with any CL (Paired t-test; all $p \leq 0.001$). Conclusion: CCT measurements cannot be performed while wearing CL. In contrast, ACD and AL measurements were not affected by the use of any CL. In addition, it was observed that ACD results from both devices are not interchangeable neither when measured with the naked eye nor using any CL.

1. Introduction

On daily routine visual assessment, numerous instruments are used for diverse ocular biometric parameters measurements of the eye, such as the central corneal thickness (CCT), the anterior chamber depth (ACD) or the total axial length (AL) [1]. The values of these parameters are relevant due to their relationship with some pathological processes; the CCT measured by pachymetry is an important tool during a follow up of conditions such as keratoconus, corneal edema or glaucoma [2]; a shallow ACD and the closure of the drainage angle have been identified as a risk factor for glaucoma as well [3]; or the AL measured by ocular biometry, has become essential in myopia control [4], as well as in conjunction with the keratometry values, being also fundamental to calculate the intraocular lens power in cataract surgery [5].

Contact lenses (CL) have become essential in patient´s daily routine, and the number of users increases every day [6]. This increase could be due to factors such as the quality of vision with the CL,

the inherent comfort for physical and leisure activities, or the full field of vision without interference from the frame; in addition, during the current situation of the COVID19 pandemic where the masks use has been mandatory by the health authorities in a high number of countries, CL have the advantage of avoiding fogging [7]. Moreover, CL are convenient in some visual conditions, such as anisometropia or keratoconus [8, 9]. For these reasons, many people wear their CL continuously and even come to their visual exams with them on. Thus, knowing how they affect the usual clinical measurements earns interest. Far from these reasons, there is an added interest in the use of CL in some measurement techniques which need the use of anaesthesia, for example, the ocular biometry by ultrasound where CL have the potential to replace the use of the drug [10].

The present study aimed to compare the values of CCT, ACD, and AL on measurements performed with and without CL in healthy subjects; and in the case of ACD, also compare the ACD values obtained by two different devices.

2. Material and Methods

2.1. Participants

A total of 20 volunteer participants (6 men and 14 women) with a mean of age 24.8 ± 2.73 (from 19 to 32 years) were recruited. The inclusion criteria were as follows: auto refracted sphere of -8.00 to +4.00 D, astigmatism of ≤ 3.00 D, and/or K values of 41 to 47 D [11]. The exclusion criteria were as follows: presence of ocular or systemic disorders that could affect the measurements, closed-angle glaucoma, history of ocular surgery and/or history of hypersensitivity to anaesthesia [12].

Informed consent was obtained from all participants for being included in the study. The study protocol was adhered to the tenets of the Declaration of Helsinki and was approved by the Ethics Committee of the University of Santiago de Compostela.

2.2. Study Design

In a single visit, participants underwent a battery of tests always in the same order with the naked eye (without CL): Autorefraction, biometry, topography and pachymetry. Then, biometry and pachymetry were repeated twice wearing two different CLs fitted in random order. The fit of each contact lens was checked with an SL-D4 slit-lamp (Topcon Corporation, Japan).

In all tests, measurements were taken by the same researcher only in the right eye of each participant to avoid inter-observer variations or overstating the precision of statistical estimates [13].

2.2.1. Contact Lens. During the protocol, two daily disposable contact lenses were fitted: Somofilcon A (Clariti 1 Day, CooperVision Inc., Pleasanton, USA) and Nesofilcon A (Biotrue ONEday, Bausch & Lomb Inc., New York, USA) [14]. Parameters of the lenses are detailed in Table 1. In all participants, the lens power used was -3.00 D.

Table 1. Parameters of the contact lenses used. USAN: United States Adopted Names.

Commercial name	Clariti 1 day	Biotrue ONEday
Manufacturer	CooperVision	Bausch & Lomb
Material	Silicone-hydrogel	Hydrogel
Material (USAN)	Somofilcon A	Nesofilcon A
Power used (D)	-3.00	-3.00
Back optic zone radius (mm)	8.6	8.6
Total diameter (mm)	14.1	14.2
Centre thickness (mm) at -3.00 D	0.08	0.1
Dk/t value at -3.00 D	86	42
Water content	56%	78%

2.2.2. Autorefraction. The NVISION-K 5001 autorefractor (Rexxam Co., Kagawa, Japan) (Figure 1A) was used to obtain non-cycloplegic refractive error measurements [15]. This device is a wide-view window autorefractor which allows a binocular view of a far fixation target to minimise instrument myopia. Precision and vertex distance settings on the device were set at 0.12 D and 12 mm respectively. Autorefraction was performed only once, and the results were used to determine if subjects were compliant with the inclusion criteria.

2.2.3. Topography and Pachymetry. Topography and Pachymetry measurement procedures were performed by the multi-diagnostic Visionix120+ (Visionix Luneau Technologies, Chartres, France) (Figure 1B) [16, 17]. This device is based on a Placido disk system projected on the corneal surface to provide all corneal topographic information and a Scheimpflug imaging-based system to perform the pachymetry. The latter uses a monochromatic blue light (455 nm) to obtain pachymetry (CCT) and ACD measurements. Topography was performed only once to know if the subjects met the inclusion requirements of the K value.

2.2.4. Biometry. The NIDEK EchoScan Ultrasound Model US-800 biometry (Nidek Co., Tokyo, Japan) (Figure 1C) was used to obtain ACD, and AL [18, 19]. The EchoScan US-800 is an ultrasonic device which applies the ultrasonic principle based on the reflection method. When the cornea is touched by the probe, an ultrasonic pulse is transmitted which is reflected from each intraocular tissue. The echo generated is received by the probe, and the time it delays coming to the probe is converted into distance. In all measurements, the instrument was set to automatically perform measurements when the probe touches the cornea. By an automatic correction process, the device averages the better three consecutive measurements to avoid the data being affected by the movement of the eye and/or probe.

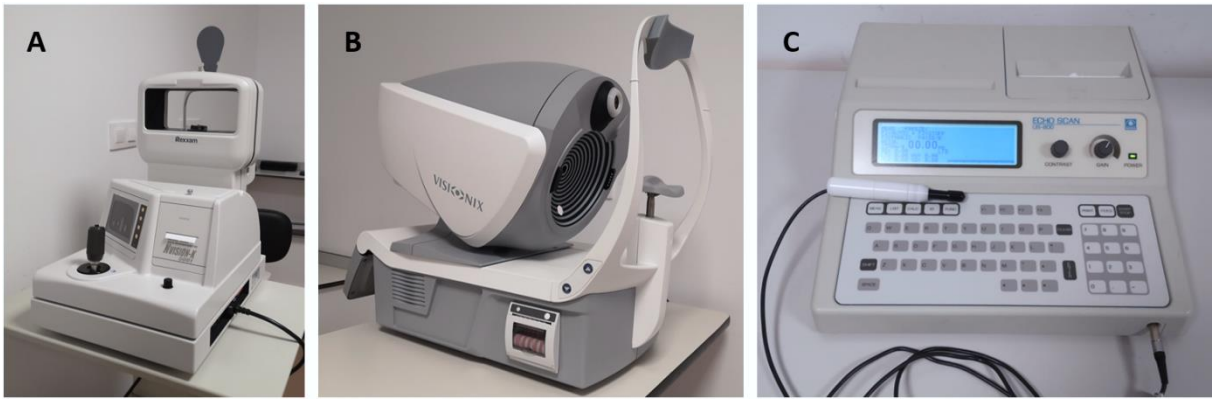

Figure 1. Devices used during the battery of test performed: (A) NVISION-K 5001 autorefractor (Rexxam Co., Kagawa, Japan); (B) Visionix120+ (Visionix Luneau Technologies, Chartres, France); (C) NIDEK EchoScan US-800 (Nidek Co., Tokyo, Japan).

2.3. Statistical Analyses

Data analysis was performed with the SPSS statistical software v. 25.0 for Windows (SPSS Inc., Chicago, IL). Significance was set at a $p \leq 0.05$ for all the tests. Previous to the analysis, the normal distribution of the data was tested using the Shapiro-Wilk test [20]; CCT, ACD and AL data showed a normal distribution (Shapiro-Wilk test: all $p \geq 0.131$). Differences between CCT with the naked eye and wearing CL, AL with the naked eye and wearing CL, and ACD with the naked eye and wearing CL measured by the Visionix120+ or EchoScan US-800 were assessed using t-tests for related samples. It was also evaluated the difference between ACD measured by Visionix 120+ or EchoScan US-800 using a t-test for related samples too.

3. Results

3.1. Differences between CCT values

CCT values obtained were significantly lower when measuring with the naked eye than while wearing any of the CL studied (paired t-test; both $p \leq 0.001$) (Table 2).

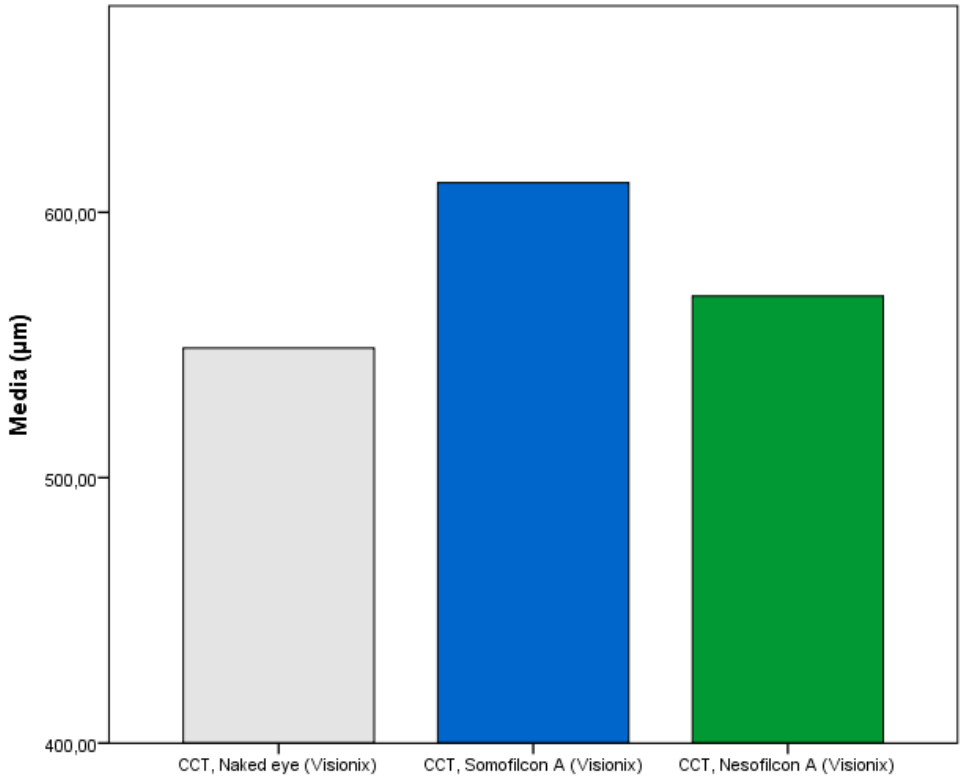

Figure 2. Differences in CCT values between measurements performed with Visionix120+ on the naked eye and both contact lenses. All values in µm. n=20.

Table 2. Descriptive statistics and differences of CCT values between measurement performed with Visionix120+ on the naked eye and both contact lenses. All values in µm. n=20. SD = Standard Deviation. 95%LoAs = 95% Limits of Agreement.

CCT	Mean ± SD	Mean difference ± SD	p	95%LoAs	
				Lower	Upper
Visionix – Naked eye	548.80 ± 40.57	-62.35 ± 23.86	<0.001	-73.52	-51.18
Visionix – Somofilcon A	611.15 ± 34.00				
Visionix – Naked eye	548.8 ± 40.57	-19.65 ± 21.58	0.001	-29.75	-9.55
Visionix – Nesofilcon A	568.45 ± 39.57				

3.2. Differences between ACD values

No statistically significant difference was found between the ACD value with the naked eye versus with any of the CL studied when during Visionix120+ measurements (paired t-test; both $p \geq 0.343$) or the EchoScan US-800 (paired t-test; both $p \geq 0.127$) (Table 3).

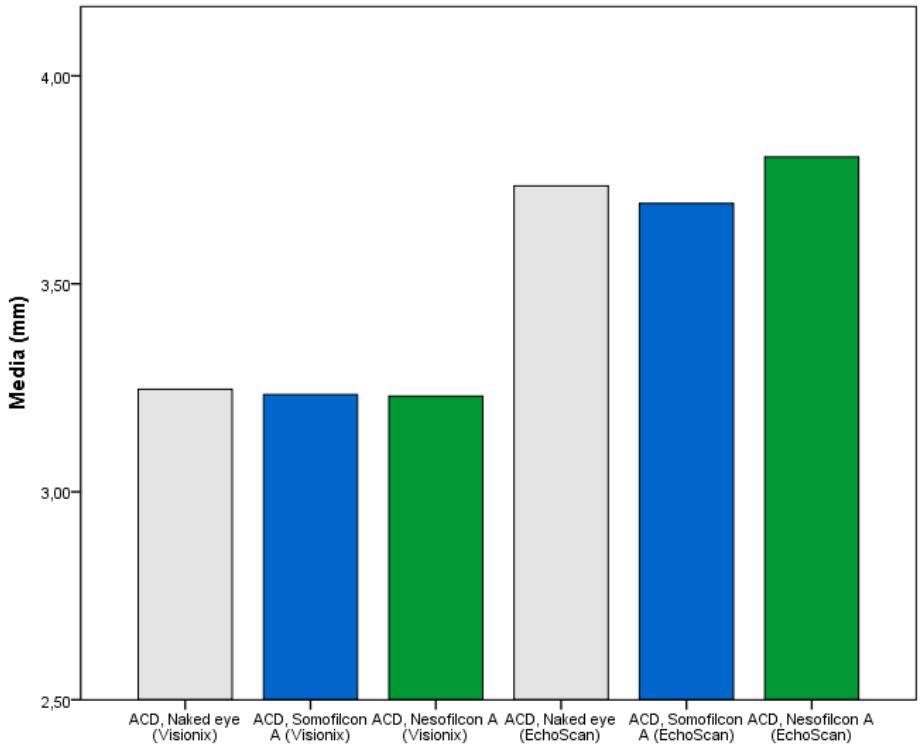

Figure 3. Differences of ACD values between measurement performed with both devices on the naked eye and contact lenses. All values in mm. n = 20.

Table 3. Descriptive statistics and differences of ACD values between measurement performed with both devices on the naked eye and contact lenses. All values in mm. n = 20. SD = Standard Deviation. 95% LoAs = 95% Limits of Agreement.

ACD	Mean ± SD	Mean difference ± SD	p	95%LoAs	
				Lower	Upper
Visionix – Naked eye Visionix – Somofilcon A	3.246 ± 0.2016 3.234 ± 0.1720	0.012 ± 0.0892	0.538	-0.0292	0.0542
Visionix – Naked eye Visionix – Nesofilcon A	3.246 ± 0.2016 3.230 ± 0.1727	0.016 ± 0.0759	0.343	-0.0190	0.0520
EchoScan – Naked eye EchoScan – Somofilcon A	3.736 ± 0.2214 3.694 ± 0.2506	0.042 ± 0.2464	0.455	-0.0733	0.1573
EchoScan – Naked eye EchoScan – Nesofilcon A	3.736 ± 0.2214 3.805 ± 0.2630	-0.070 ± 0.1950	0.127	-0.1607	0.0217

The ACD with the naked eye was significantly different when values were compared between Visionix120+ or EchoScan US-800 measurements (paired t-test, $p < 0.001$), as well as while wearing any of the CL studied (paired t-test; all $p \leq 0.001$); in all three cases, the EchoScan US-800 obtained higher ACD values than those obtained by Visionix120+ (Table 4).

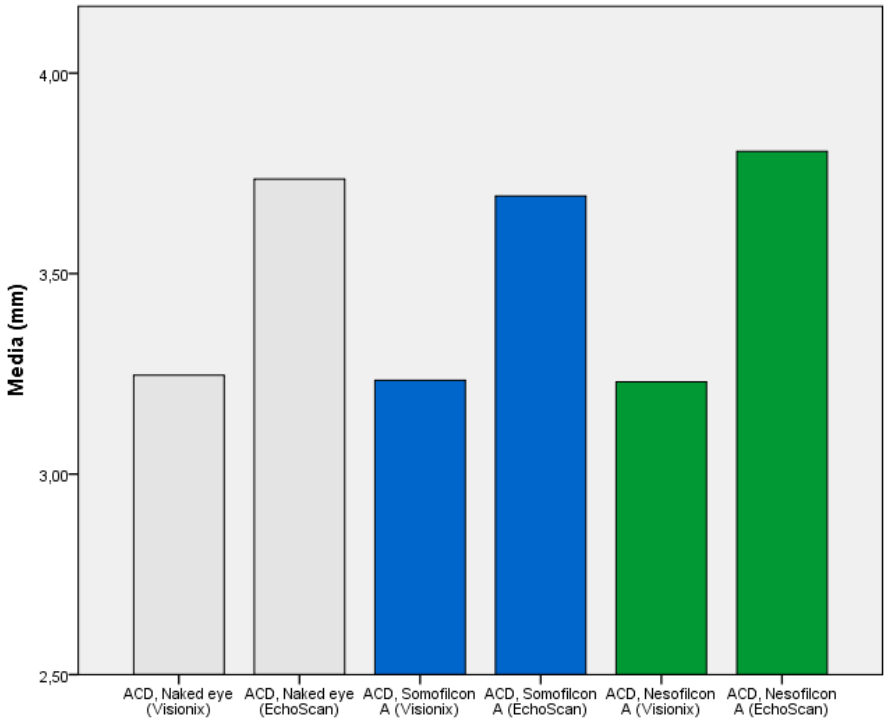

Figure 4. Differences of ACD values comparing both devices on the naked eye and contact lenses. All values in mm. n = 20.

Table 4. *Descriptive statistics and differences of ACD values comparing both devices on the naked eye and contact lenses. All values in mm. n = 20. SD = Standard Deviation. 95% LoAs = 95% Limits of Agreement.*

ACD	Mean ± SD	Mean difference ± SD	p	95%LoAs	
				Lower	Upper
Visionix – Naked eye	3.246 ± 0.2016	-0.489 ± 0.1458	<0.001	-0.5573	-0.4207
EchoScan – Naked eye	3.736 ± 0.2214				
Visionix – Somofilcon A	3.234 ± 0.1720	-0.460 ± 0.2194	<0.001	-0.5622	-0.3568
EchoScan – Somofilcon A	3.694 ± 0.2506				
Visionix – Nesofilcon A	3.230 ± 0.1727	-0.575 ± 0.1811	<0.001	-0.6600	-0.4902
EchoScan – Nesofilcon A	3.805 ± 0.2630				

3.3. Differences between AL values

There were no significant differences when comparing AL with the naked eye and while wearing any of the CL studied (paired t-test; both $p \geq 0.111$) (Table 5).

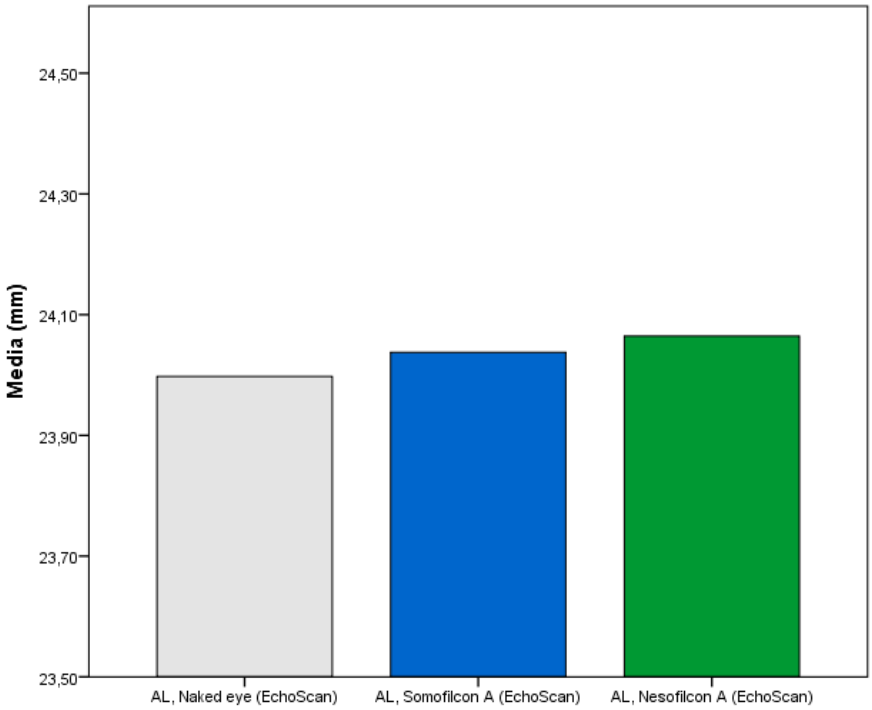

Figure 5. Differences of AL values between measurement performed with EchoScan US-800 on the naked eye and both contact lenses. All values in mm. n = 20.

Table 5. Descriptive statistics and differences of AL values between measurement performed with EchoScan US-800 on the naked eye and both contact lenses. All values in mm. n = 20. SD = Standard Deviation. 95% LoAs = 95% Limits of Agreement.

AL	Mean ± SD	Mean difference ± SD	p	95%LoAs	
				Lower	Upper
EchoScan – Naked eye	24.000 ± 1.1457	-0.040 ± 0.1870	0.350	-0.1275	0.0474
EchoScan – Somofilcon A	24.038 ± 1.1376				
EchoScan – Naked eye	24.000 ± 1.1457	-0.067 ± 0.1792	0.111	-0.1508	0.0170
EchoScan – Nesofilcon A	24.064 ± 1.0787				

4. Discussion

The use of CL is widespread being a possible limitation during clinical assessment such as some measurements of the daily routine visual evaluation could be affected by them. The current study aimed to assess how their use impacts the CCT, ACD and AL measurements. The principal finding of the current study is that the use of CL while measuring ACD or ocular biometry does not affect the results. This means that these techniques can be performed even if the subjects choose not to remove their CL. On the other hand, the measurement technique that cannot be performed with CL is pachymetry, since it has been found that CL thickness affects the CCT measurement. Devices that measure pachymetry by optical low-coherence reflectometry measure CCT from the endothelium [21], although in the case of the Visionix120 this data is unknown, so it could be including the CL or tear lens thickness.

The difference between the pachymetry with the naked eye versus wearing Somofilcon A was -62.35 µm. Considering that Somofilcon A thickness at -3.00 D power is 80 µm (data provided by the manufacturer) and the resolution of pachymetry by Visionix120+ is ±10 µm, it can be considered that the effect of CL wearing in pachymetry was consistent with the CL thickness. The opposite situation

was found with the Nesofilcon A: the difference between pachymetry with the naked eye versus wearing Nesofilcon A was -19.65 μm, different from the 100 μm of the CL thickness at -3.00 D power (data provided by the manufacturer). A possible hypothesis for the variation in CCT could be a transient corneal hypoxia due to the use of CL; however, considering the time of use and the Dk/t of these CLs, it is precisely the one with the highest Dk/t that generates the greatest variation, therefore, this theory is dismissed. Even so, the differences may be related to the CL and not to the device because the multi-diagnostic Visionix120+ has been found a reliable platform with high levels of repeatability [17]. Therefore, it could be hypothesized that the CL must be removed before performing pachymetry measurements to obtain reliable results.

It was also checked if results of ACD measured by Visionix120+ and EchoScan US-800 could be interchanged, and it was found that EchoScan US-800 obtained significantly higher ACD values than Visionix120+ when measuring with the naked eye or with either lens. Therefore, the results of these devices cannot be compared to each other. The results of this study disagree with those found by Ferrer-Blasco et al. [12], whose study showed a significant increase in CCT, but also in ACD and AL when comparing naked eye measurements versus CL wearing. Changes in these parameters were directly correlated with the CL thickness. Similar results were obtained for AL in a previous study; CL modified the AL value, and these changes were correlated with the CL thickness measured by OCT [22].

One of the main limitations of the present study was the use of contact biometry since it depends on the examiner's ability to locate the probe correctly and always in the same eye position. Moreover, it is necessary to touch the cornea when performing the measurements and the pressure in the cornea could change the AL or ACD to a lower value. However, in this study, higher ACD values were found in EchoScan US-800 measurements than in Visionix120+, both when measured with the naked eye and wearing any CL.

In conclusion, the results of this study showed that CCT measurements obtained by Visionix120+ were affected when measuring with the naked eye or wearing CL. In contrast, ACD and AL measurements were not affected by the use of any CL. Thus, the use of CL to perform measurements with the EchoScan US-800 may have the potential to avoid the use of anaesthesia.

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