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Effects of Hydrogel Contact Lens on Corneal Biomechanics and Intraocular Pressure

Hidrojel Kontakt Lensin Kornea Biyomekaniği ve Göz İçi Basıncı Üzerine Etkileri

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Abstract

INTRODUCTION: To compare the corneal biomechanical parameters and intraocular pressure (IOP) measurements with Ocular Response Analyzer (ORA) and non-contact tonometry (NCT) before and after contact lens (CL) application.
METHODS: Fifty-eight healthy individuals were included in this prospective study. Only one eye of each individual was chosen randomly in. Corneal hysteresis (CH), corneal resistance factor (CRF), Goldmann-correlated IOP (IOPg), corneal-compensated IOP (IOPcc) measured by ORA, and IOP measured by NCT were compared before and an hour after the hydrogel CL (with back vertex power of −3.00 Diopter) (1-Day Acuvue Moist-Etafilcon A, Johnson&Johnson) application. The data were analysed using a paired sample t-test.
RESULTS: Fifty-eight eyes of 58 participants were included in the study. 19 participants were female and 39 were male. The mean age of the participants was 26.53 ± 5.09. There was no statistically significant difference between the measurements of two different devices (measurements without and with CL p = 0.230 and p = 0.790, respectively). All measurements with CL were lower than those without CL, but only NCT, IOPcc and IOPg values were statistically significantly lower (p values <0.001, 0.023, and 0.001, respectively).
DISCUSSION AND CONCLUSION: ORA measurements with CL caused lower values in all ORA parameters, and these differences reached statistically significant levels in IOPcc and IOPg values. CH and CRF values were not statistically significantly affected by CL wear. Similar to ORA, low IOP measurements were found with NCT.

Keywords: Contact lens, ocular response analyzer, corneal hysteresis, corneal resistance factor

Öz

GİRİŞ ve AMAÇ: Oküler Cevap Analizörü (OCA) ve non-kontakt tonometre (NCT) kullanılarak, kontakt lens (KL) uygulamasından önce ve sonraki korneal biyomekanik parametreleri ve göz içi basıncı (GİB) ölçümlerini karşılaştırmak.
YÖNTEM ve GEREÇLER: Bu prospektif çalışmaya 58 sağlıklı birey dahil edildi. Her bireyin sadece bir gözü rastgele seçildi. Hidrojel KL uygulamasından önce ve bir saat sonra OCA ile ölçülen kornea histerezisi (KH), kornea direnç faktörü (KDF), Goldmann-korelasyonlu GİB (GİBg), korneal kompanse GİB (GİBkk) ve NCT ile ölçülen GİB karşılaştırıldı (arka tepe gücü −3.00 Diopter) (1-Day Acuvue Moist-Etafilcon A, Johnson & Johnson). Veriler, t-testi kullanılarak analiz edildi.
BULGULAR: Çalışmaya 58 katılımcının 58 gözü dahil edildi. 19 katılımcı kadın, 39 erkek idi. Katılımcıların yaş ortalaması 26.53 ± 5.09'du. İki farklı cihazın ölçümleri arasında istatistiksel olarak anlamlı bir fark yoktu (KL olmadan ve KL ile ölçümlerde sırasıyla p = 0,230 ve p = 0,790). KL ile yapılan tüm ölçümler, KL olmayanlardan daha düşüktü, ancak yalnızca NCT ile ölçülen GİB, OCA ile ölçülen GİBkk ve GİBg değerleri istatistiksel olarak anlamlı derecede daha düşüktü (sırasıyla p değerleri <0.001, 0.023 ve 0.001).
TARTIŞMA ve SONUÇ: KL ile OCA ölçümleri tüm OCA parametrelerinde daha düşük değerlere neden oldu ve bu farklılıklar GİBkk ve GİBg değerlerinde istatistiksel olarak anlamlı seviyelere ulaştı. KL kullanılmasından KH ve KDF değerleri istatistiksel olarak anlamlı şekilde etkilenmedi. OCA'ya benzer şekilde, NCT ile düşük GİB ölçümleri bulundu.

Anahtar Kelimeler: Kontakt lens, oküler cevap analizörü, kornea histerezisi, kornea direnç faktörü

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INTRODUCTION

Non-contact tonometry (NCT) is a popularly used technology for clinical measurement of IOP. This technology is the easiest and fastest to check whether a patient has a normal, low or high IOP. It includes the use of flowing air to achieve results, as there is no contact between the patient's eye and the device. However, it cannot measure the biomechanical properties of the cornea.

The ocular response analyzer (ORA, Reichert; USA) is an instrument that is based on NCT, ORA uses air pressure to applanatethecentralcorneatomeasureintraocularpressure(IOP) like NCT. ORA is also used to measure corneal compensated IOP (IOPcc) which is a helpful in getting a more accurate IOP (1). Goldmann-compatible IOP (IOPg) is an identical analysis that averages these applanation powers. Other features of ORA include measuring corneal hysteresis (CH) and corneal resistance factor (CRF). CH describe viscoelastic character of cornea. CRF shows corneal resistance to deformation as a whole (2). CH and CRF are important in assessing corneal biomechanical features features that NCT can not measure. So, ORA is useful against most of the diseases that could affect the eye (glaucoma, keratoconus, psoriasis, etc.) (3-7).

Hydrogel material is increasingly used for contact lenses (CL) (8,9). Especially daily disposable contact lenses have many advantages over reusable lenses.After each use, it is easier to disinfect the lenses, and in case of loss or damage to the lens, spare contact lenses are ready (10).

In literature there are a lot of studies with NCT and CL but, ORA and CL have not been studied widely. In this study, we aimed to assess IOPcc, IOPg, CH, and CRF using ORA, in patients with daily disposable hydrogel CL.

METHODS

Study design

In this prospective, single-center, interventional study: we recruited participants with hydrogel CL between June 2018 and March 2019. This study design was approved by the Clinical Studies Ethics Council of the Faculty of Medicine, Adnan Menderes University, Aydin, Turkey. All procedures in this study confirm to the terms of the Declaration of Helsinki.

Patients

Participants between 21-45 years old that have not had any ocular medication previously were included in the study. Soft CL wearers were asked to discontinue wearing CLs at least 24 hours before measurements. Moreover, participants with rigid contact lens wear, glaucoma, any corneal pathologies, chronic systemic diseases that could probably affect the eye (diabetes mellitus, hypertension, autoimmune diseases, etc.) or history of previous ocular surgery were excluded.

ORA measurement principles

ORA allows classification of various corneal parameters based on biomechanical tissue properties by quantifying the differential inward and outward corneal reply to an air pulse. After the desired indentation of the cornea by air stroke, the cornea returns to its initial state in reverse. Meanwhile the corneal deformation is recorded by an electro-optic infrared determination process and two applanation measurements are received. The ORA makes two different IOP output values: IOPg and the IOPcc. As the ORA analysis process, the cornea absorbs some energy from the initial air pulse, so this situation makes the secondary applanation pressure value to be lower than the first value. The difference between the two pressures (P1: first applanation pressure point, P2: second applanation pressure point) is called CH, mm Hg (11). The CRF is determined by the description (P1-kP2) where k is the uniform defined from an empirical value of the relation in P1, P2, and CCT.

Ophthalmic examination

Only one eye from each participant was randomly chosen for examinations. After informed consent, an ophthalmologic examination including anterior and posterior segment examinations with slit-lamp biomicroscopy, IOP and corneal parameters measured with ORA (CH, CRF, IOPcc, and IOPg) and NCT measurements was performed before the procedure. The same clinician measured IOPwith the same device; however, an independent technician read and recorded the results of the measurements to reduce the risk of bias. To avoid any deviation from diurnal variation, all measurements with ORA were taken at a similar time of day (10 am ± 1 h).

ORAand NCT measurements were performed at baseline and 10 minutes after CL application (for lens stabilization according to Lam et al.[12]). Hydrogel CL with back vertex power of −3.00 Diopter was applied to all patients (1-Day Acuvue Moist-Etafilcon A, Johnson & Johnson Vision Care, 58% water, 8.5 mm base curve, 14.2 mm diameter, center thickness 0.084 mm). Topical anesthesia was not used in any patient during CL application.

Statistical analysis

We used E-PICOS software (New York) for statistical analysis. To evaluate the normality of numeric variables, the Kolmogorov-Smirnov test was utilized. Descriptive statistics were displayed as a "mean ± standard deviation" and displayed as frequency (%). Bland–Altman plotting was used to evaluate the limits of agreement between the measures without and with CLs. The paired sample t-test was used to determine the mean difference between the two sets of observations. A p value of less than 0.05 was thought to be statistically significant.

RESULTS

Fifty-eight eyes of 58 participants were included in the study.

Table 1: Mean IOP, IOPcc, IOPg, CH and CRF values of the patients before (Without CL) and after (With CL) contact lens wear

	IOP (NCT) Mean ± SD	IOPcc Mean ± SD	IOPg Mean ± SD	CH Mean ± SD	CRF Mean ± SD
Without CL	14.69 ± 2.56	14.13 ± 2.46	13.14 ± 2.35	9.18 ± 1.10	10.24 ± 1.19
With CL	13.60 ± 2.77	13.74 ± 2.84	12.36 ± 2.84	9.02 ± 1.37	10.18 ± 1.39
p values	**<0.001***	**0.023***	**0.001***	0.207	0.715

*SD: standard deviation; IOP: intraocular pressure; NCT: non-contact tonometry; IOPcc: corneal-compensated intraocular pressure; IOPg: Goldmann correlated intraocular pressure; CH: corneal hysteresis; CRF: corneal resistance factor; CL: contact lens; *: statistically significant (p <0.05)*

Of these cases, 19 (32.76%) were female and 39 (67.24%) were male. The mean age was 26.53 ± 5.09 years (age range between 21-45 years).

The mean IOP measured via the NCT without and with CL were 14.69 ± 2.56 and 13.60 ± 2.77 mm Hg, respectively. The mean IOPcc measured via the ORA without and with CL were 14.13 ± 2.46 and 13.74 ± 2.84 mm Hg, respectively. There was no statistically significant difference between the measurements of two different devices (measurements without and with CL p = 0.230 and p = 0.790, respectively). The mean IOPg measured via the ORA without and with CL were 13.14 ± 2.35 and 12.36 ± 2.84 mm of Hg, respectively. In addition to mean IOPs, also CH and CRF values in without CL / with CL wearing patients are given in Table 1.

With CL, IOPcc and IOPg values measured statistically significantly lower than values which measured without CL group (p = 0.023 and p = 0.001, respectively). On the other hand, CH and CRF measurements with CL and without CL were not significantly different via paired t-test (p = 0.207 and p = 0.715, respectively). The limits of agreement between CH (Figure 1a) and CRF (Figure 1b) measurements without and with CLs were presented in a Bland–Altman plot.

DISCUSSION

ORA is a tonometer that measures IOP, CH and CRF without requiring anaesthesia. To our knowledge, CL effects on ORA measurements have not been widely studied previously. Daily disposable contact lenses are superior compared to reusable lenses. Lens-based deposits in the corneal epithelium or tarsal conjunctiva are less when a new lens is worn every day (13). Therefore, in our study, we decided to evaluate daily disposable CLs.

We compared the values measured using ORA and NCT in patients without and with CL application. In our study, all measurements decreased with CL. Out of all these only IOP parameters were significantly decreased (p <0.05). Changes in CH and CRF parameters were not statistically significant.

In some studies, IOP measurements by Dynamic Contour Tonometry (DCT), I-care, and non-contact tonometers were not affected by wearing CL (14-16). In our study, IOPs measured significantly low with ORA and NCT but, CH and CRF were not affected that measurements with ORA. I-care and NCTs do not have these properties (measuring CH and CRF).

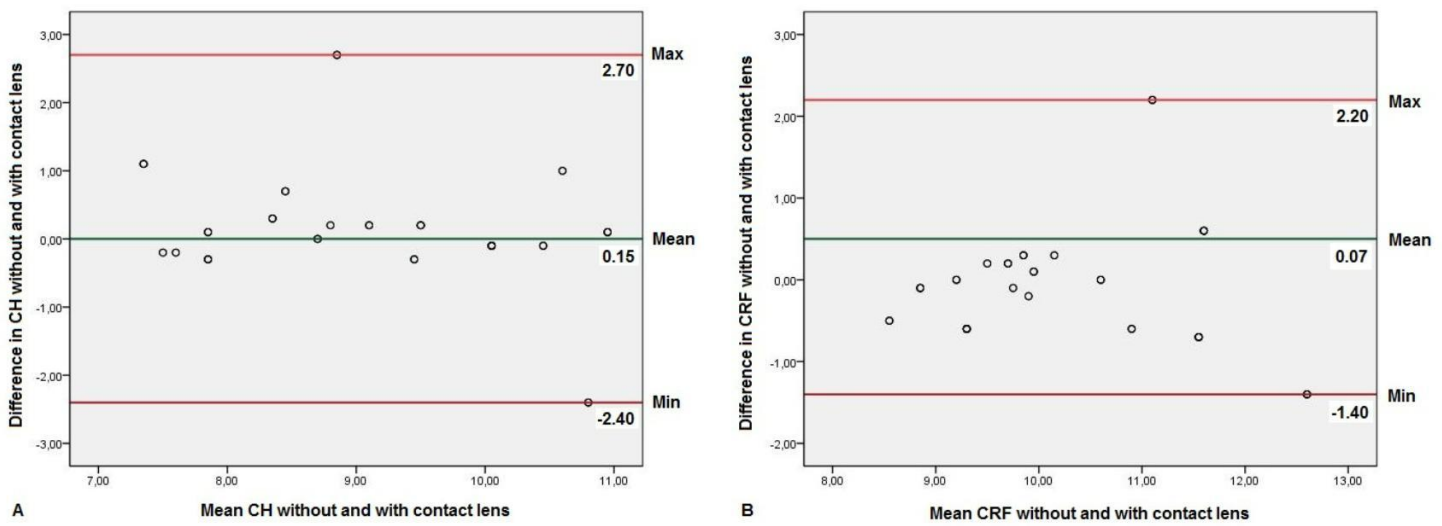

Figure 1: Bland–Altman plot showing agreement between the CH (a) and CRF (b) measured by ORA without and with contact lenses
**CH: corneal hysteresis; CRF: corneal resistance factor; ORA: ocular response analyzer*

Measuring IOP with non-contact tonometers reduces the risk of infection, CL malposition, CL deformity and corneal erosion (17,18).However,NCTscannotmeasurecornealparameterssuch as CH and CRF, unlike ORA. Especially in vulnerable corneas, there is an increase in the risk of corneal erosion and infection by wearing and removing the contact lens (19). Contact lenses have various therapeutic applications in the treatment of corneal diseases other than visual improvement. Common indications for contact lenses are usually supporting corneal healing, promoting epithelialization or wound closure, mechanical protection and support for the cornea, controlling corneal hydration, relieving pain, frequently a combination of outcomes being performed (20,21). Since frequently wearing and removing CLs delays wound healing, we found lower intraocular pressures in ORA measurements especially performed in this CL wearing group.

Patel et al., investigated the effect of contact lens power and water content on IOP measurement using NCT (22). They found that the use of a contact lens with high water content and under 3 diopter lens power did not cause a significant error in the NCT measurement. Although, -3 diopter lenses were used in our study, we found a statistically significant decrease in both IOP measurements.

CH is associated with glaucoma appearance, progression, and effectiveness of glaucoma therapies (23). Studies indicate that especially low CH poses a high risk for glaucoma progression and that CH measurements should be included in clinical use in the follow-up of glaucoma patients (24-28). Additionally, CRF is an indicator for patients with keratoconus, psoriasis, systemic sclerosis, etc (4,29,30).

Using ORA helps us measure corneal biomechanical values. We observed that there was no significant difference in CH and CRF values after the application of hydrogel lenses. To follow up CH and CRF, ORA might be useful in patients who usually have to wear hydrogel CL (eg in corneal epithelial defect, high refractive error, keratoconus, etc.). In our experimental study, we thought that corneal biomechanical properties, especially CH and CRF measurements, could be measured differently by using CLs. However, according to current results, no clinically significant changes were observed in CH and CRF.

The main limitation of our study was that corneal thicknesses could not be evaluated. On the other hand, there are some strengths of the study like the large number of participants, real-life study and its prospective nature. Also, we compared two different devices.

In conclusion, there were similar IOP results with ORA and NCT. Via ORA, we do not need to remove CLs for assessing CH and CRF with patients who use daily CLs. Nevertheless, further studies are probably necessary to assess ORA's effect with different kinds of CL's and different time intervals measures.

Ethics Committee Approval: Adnan Menderes University Faculty of Medicine Non-Invasive Clinical Research Ethics Committee (27.08.2015 / 2015/659)

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Informed Consent: Informed consent was taken from all individual participants.

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