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ORIGINAL ARTICLE

Dynamic contour tonometry over silicone hydrogel contact lens

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KEYWORDS
Corneal hysteresis;
Corneal resistance factor;
Intraocular pressure;
Ocular pulse amplitude;
Lens modulus

Abstract
Purpose: This study compared the measurements of intraocular pressure (IOP) and ocular pulse amplitude (OPA) using the Dynamic Contour Tonometry (DCT) over silicone hydrogel contact lenses of different modulus. Corneal biomechanics were also measured using the Ocular Response Analyzer (ORA).
Methods: Forty-seven young (mean age 22.3 years, standard deviation 1.2 years) subjects had IOP, OPA, corneal hysteresis (CH) and corneal resistance factor (CRF) measured without lens and with two brands of silicone hydrogel contact lenses. Each eye wore one brand followed by another, randomly assigned, and then the lenses switched over. Difference and agreement of IOP and OPA with and without silicone hydrogel contact lens were studied.
Results: The right and left eyes had similar corneal curvatures, central corneal thicknesses, IOP, OPA and corneal biomechanics at baseline. No significant difference was found in CH and CRF when they were measured over different contact lenses. IOP demonstrated a greater difference (95% limits of agreement: 2.73 mmHg) compared with no lens when it was measured over high modulus silicone hydrogel lenses. Agreement improved over low lens modulus silicone hydrogel lenses (95% limits of agreement: 2.2–2.4 mmHg). 95% limits of agreement were within 1.0 mmHg for OPA.
Conclusions: This study demonstrated the feasibility of DCT over silicone hydrogel lenses. Low lens modulus silicone hydrogel contact lens in situ has no clinical effect on DCT.

PALABRAS CLAVE
Histéresis corneal;
Factor de resistencia corneal;
Presión intraocular;
Amplitud del pulso ocular;
Módulo de la lente

Tonometría de contorno dinámico en lentes de contacto de hidrogel de silicona

Resumen
Objetivo: Este estudio comparó las mediciones de la presión intraocular (PIO) y la amplitud del pulso ocular (APO) utilizando la tonometría de contorno dinámico (TCD) en lentes de contacto de hidrogel de silicona con módulos diferentes. También se midió la biomecánica corneal utilizando el analizador de respuesta ocular (ORA).
Métodos: Se midieron la PIO, APO, histéresis corneal (HC) y factor de resistencia corneal (FRC) de cuarenta y siete jóvenes pacientes sin y con dos marcas diferentes de lentes de contacto de

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hidrogel de silicona. A cada ojo se le colocó una lente seguida de la otra marca, elegida al azar, intercambiándose posteriormente las lentes. Se estudiaron la diferencia y la concordancia de la PIO y la APO con y sin lentes de contacto de hidrogel de silicona.
Resultados: Los ojos derechos e izquierdos tenían similares curvaturas, espesores corneales centrales, PIO, APO y biomecánica corneal como punto de partida. No se observó una diferencia significativa en cuanto a HC y FRC al medirse en las diferentes lentes de contacto. La PIO mostró una mayor diferencia (límites de concordancia al 95%: 2,73 mmHg) en comparación a la no utilización de lentes, al medirse en las lentes de hidrogel de silicona con elevado módulo de rigidez. La concordancia mejoró en las lentes de hidrogel de silicona con bajo módulo (límites de concordancia al 95%: de 2,2 a 2,4 mmHg). Los límites de concordancia al 95% se situaron dentro de un valor de 1,0 mmHg para la PAO.
Conclusiones: Este estudio demostró la viabilidad de la TCD en las lentes de hidrogel de silicona. Las lentes de contacto de hidrogel de silicona con bajo módulo in situ no tienen un efecto clínico significativo sobre la TCD.

Dynamic contour tonometry (DCT) is a contact procedure where the tonometer probe has a concave surface contour. There is a miniaturized pressure sensor integrated into the center of the contact surface so not only the intraocular pressure (IOP) can be measured, but also the changes in IOP, termed ocular pulse amplitude (OPA) can be obtained. With its special probe design, IOP measured by it has been found not to be affected by central corneal thickness (CCT),[1–5] corneal curvature [1–4] and corneal astigmatism.[1,3] IOP measurement from DCT showed good concordance with intracameral IOP.[6]

To prevent cross contamination in contact tonometry, Goldmann applanation tonometry (GAT) can be performed with soft hydrogel[7] or silicone hydrogel[8] contact lens in situ. There is no effect on the accuracy of GAT from contact lens wear. Nosch et al.[9] reported that accurate IOP could be obtained from DCT over a thin soft hydrogel contact lens. However, OPA was measured about 5% lower. Since IOP (around 18 mmHg) has a magnitude nearly 5 times higher than OPA (around 3 mmHg), OPA measurement could be more sensitively affected with contact lens in situ. Recently, Gogniat et al.[10] found that OPA was not affected by contact lens materials or lens power. Interestingly, a significant difference in IOP was observed when it was measured with hydrogel lens but not with silicone hydrogel lens of the same power. They postulated that the stiffness of the silicone hydrogel material may provide a more stable surface for the DCT sensor tip to rest on. Silicone hydrogel lens comes with different stiffness, in terms of lens modulus. Effect of lens material on DCT is unknown.

Applanation tonometry over a contact lens in situ could eliminate topical anesthesia. This would be useful in some European countries as well as in some Asian countries such as Singapore, Taiwan, Malaysia and Korea where optometrists are not allowed to use topical anesthetics. Nowadays, silicone hydrogel contact lens is very popular in particular to be used as a bandage contact lens.[11–14] Accurate IOP measurement over silicone hydrogel contact lens will be beneficial to these patients. Newer silicone hydrogel materials have lower modulus (or less stiff). This study aimed at investigating the effect of silicone hydrogel contact lenses of different modulus on IOP and OPA measurements.

Ocular Response Analyser (ORA) is a non-contact tonometer (NCT) which can measure corneal biomechanical properties.[15,16] The corneal biomechanical properties measured are corneal hysteresis (CH) and corneal resistance factor (CRF). Both CH and CRF have been found to be reduced after refractive surgeries.[17–20] This study also included corneal biomechanics measurement to see if CH and CRF were affected when they were measured over different silicone hydrogel contact lenses.

Methods

Normal young healthy subjects were recruited. Exclusion criteria included subjects with rigid contact lens wear, corneal astigmatism more than 2D, and history of any ocular diseases. Soft contact lens wearers were required to stop contact lens wear for at least 24 hours. This study was approved by the ethics committee of the University and was carried out with due regard to the tenets of the Declaration of Helsinki. Details of the study were given to subjects before informed consent was obtained.

Two brands of silicone hydrogel contact lenses with different modulus were used. They were Ciba Vision Air Optix® Focus Night & Day® Aqua (N&D) and Acuvue® Advance® (AA). All the lenses used had back vertex power of −3.00D. These lenses shared similar lens overall diameter (13.8 mm versus 14.0 mm), center thickness (0.08 mm versus 0.07 mm) and base cure (8.4 mm versus 8.3 mm). Their lens modulus values were different (1.5 MPa versus 0.43 MPa, respectively).

After informed consent, each subject had CH and CRF measured by ORA (Reichert Ophthalmic Instruments, Buffalo, NY), corneal topography and central corneal thickness (CCT) measured by Pentacam Classic (Oculus Inc, Germany) on both eyes. All these procedures were non-contact. In ORA, three measurements were obtained each with a waveform score of at least 3.50.[16] In corneal topography, three images were captured using the 50-scan mode and all scans were registered as ''OK'' for quality assurance.[21] The corneal power, in terms of SimK, was converted to its vector form (M, J_0 and J_{45}) for analysis.[22]