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Original research

Corneal aberration changes after rigid gas permeable contact lens wear

Fereshteh Shokrollahzadeh [a], Hassan Hashemi [b], Ebrahim Jafarzadehpur [c,*], Ali Mirzajani [c], Mehdi Khabazkhoob [d], Abbasali Yekta [e], Soheila Asgari [f]

[a] *Noor Research Center for Ophthalmic Epidemiology, Noor Eye Hospital, Tehran, Iran*
[b] *Noor Ophthalmology Research Center, Noor Eye Hospital, Tehran, Iran*
[c] *Department of Optometry, School of Rehabilitation Science, Iran University of Medical Sciences, Tehran, Iran*
[d] *Department of Medical Surgical Nursing, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran*
[e] *Department of Optometry, School of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran*
[f] *Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, International Campus, Tehran, Iran*

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Abstract

Purpose: To determine the short-term effect of rigid gas permeable (RGP) contact lenses on corneal aberrations in keratoconic patients.
Method: Sixteen keratoconic eyes with no history of RGP lens wear were included. They all had corneal aberrometry using Pentacam, and different aberration indices of the anterior and posterior surfaces of the cornea were measured before and 3 months after fitting RGP lenses. The effect of baseline parameters on these changes was tested in univariate and multiple models.
Results: Total aberrations and individual Zernike coefficients did not show statistically significant changes after using RGP lenses. Although not statistically significant, vertical coma decreased in the anterior ($p = 0.073$) and posterior surface ($p = 0.095$). Relationships that remained statistically significant in the multiple model were between baseline central corneal thickness and changes in total higher order aberrations and anterior 4th order astigmatism 0°, and between baseline 2nd order astigmatism 45° and its changes.
Conclusion: In this study, corneal aberrations remained unchanged 3 months after wearing RGP contact lens. Further studies with sufficient samples in different groups of keratoconus severity or baseline aberrations are needed to obtain more accurate results.

Keywords: Aberrometry; Keratoconus; Rigid gas permeable contact lens; Pentacam

Introduction

The cornea is a major source of aberrations which can cause limitations in visual acuity and quality.[1–3] In keratoconus patients, decreased visual acuity is one of the main complaints, and in comparison with normal corneas, keratoconic eyes exhibit many corneal irregularities, irregular astigmatism, and aberrations.[4–7] Coma, especially vertical coma, is the most common aberration in keratoconic patients.[8] These aberrations are found and can be evaluated in both the posterior and anterior surfaces of the cornea.[9] Measuring corneal aberrations changes improves our understanding of the changes in the shape and optical properties of the cornea and keratoconus progression.[10] Studies suggest that vertical coma and total root mean square (RMS) aberrations are the best aberrometry indices to detect keratoconus.[11–13]

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* Corresponding author.
E-mail address: jafarzadehpour.e@iums.ac.ir (E. Jafarzadehpur).
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Vision improvement in keratoconic patients can be achieved through the use of contact lenses or surgical methods such as corneal ring implantation and corneal grafting. Rigid gas permeable (RGP) lenses, the first lens choice for keratoconic patients, are believed to change corneal astigmatism as a result of the optical characteristics of the tear layer behind the lens.[14] However, studies in this regard are inconclusive; they vary in methodology and follow-up time, and there are still many questions concerning the effects of RGP lenses on different corneal parameters.[15–18] This study was designed to examine changes in the total RMS and Zernike polynomials in keratoconic patients after 3 months of RGP lens wear.

Method

In this prospective, before–after case series, patients with mild to severe keratoconus referring to the contact lens clinic were included. The study was approved by the Ethics Committee of Iran University of Medical Science. All patients had already had complete ophthalmic evaluation by a cornea specialist, based on which the diagnosis of keratoconus was made and confirmed through imaging modalities. Objectives and methods of the study were explained to patients, and they all signed informed consents before participation in the study.

Inclusion criteria were age between 19 and 35 years and being eligible for fitting RGP spherical lenses. Patients with a history of RGP lens use, corneal scarring, infectious or inflammatory ocular diseases, corneal graft surgery, ring implantation or corneal collagen crosslinking, and those referred for fitting mini-scleral and ClearKone lenses were excluded.

Patients had complete ocular examination including the measurement of visual acuity using a Snellen chart (Nidek-34605-6004-LCD Chart, Japan) at 4 m, objective refraction with a retinoscope (HEINE BETA 200, Germany) and an autorefractometer (Nidek, Japan), and subjective refraction with a trial lens set and frame. The appropriate aspheric RGP lens (Iran, Lens Gostar, Tehran, Iran) was prescribed using the diagnostic fitting method.[19] On slit-lamp examination, good tear exchange was verified by observing the fluorescein pattern with mild apical clearance over the corneal cone and slight edge and midperipheral clearance.[20] Patients were instructed to wear their lenses 3 h a day during the first week, and add an hour a day per week up to a maximum of 8 h daily. Follow-up calls were made to patients to stay in touch with them and ensure adherence to the study protocol.

To measure aberrations of the anterior and posterior surfaces of the cornea at baseline and at 3 months, we used the Pentacam corneal topographer (Oculus Optikgeräte GmbH, Wetzlar, Germany) which has shown to be highly reliable.[21] Extracted indices for the anterior and posterior corneal surfaces included the total RMS, 2nd order astigmatism 45°, 3rd order coma 0° and 90°, 3rd order trefoil 0° and 30°, and 4th order secondary astigmatism 0° and 45° measured over a 6.0 mm aperture.

Statistical analyses were done using the Statistical Package for Social Sciences (SPSS) Version 20.0 (Chicago, IL, USA). Results were compared using repeated measures analysis of covariance (ANCOVA), and the correlation between fellow eyes was accounted for. Changes were considered significant based on a significance level of 5%. Relationships between aberration changes and other variables were also explored using single and multiple linear regression analyses.

Results

A total of 10 patients, 3 women and 7 men, with a mean age of 27.2 ± 4.9 years (range, 20–35) were enrolled, and their 16 keratoconic eyes were evaluated. Based on the indices and classification scheme suggested by Rabinowitz, the number of eyes that could be classified as keratoconus and early keratoconus was 12 and 4, respectively.[22] The diameter of the prescribed RGP lenses was 9.60 mm in all cases, and they had a mean base curve radius of 7.70 ± 0.28 mm (range, 7.20–8.10) and a mean power of −1.56 ± 1.26 diopters (D) (range, −3.00 to ±1.25). At baseline, patients had a mean maximum keratometry reading of 54.06 ± 5.73D (range, 43.90–67.10 D), mean central corneal thickness (CCT) of 468.40 ± 56.11 μm (range, 381–547), and mean anterior Q-value of −0.80 ± 0.39 (range, −1.52 to −0.28), as determined with the Pentacam. Table 1 presents the mean values for these variables at 3 months and their changes.

Studied aberrations in the anterior and posterior corneal surface before and 3 months after using RGP lenses are summarized in Table 1. None of the studied aberration indices in the anterior or posterior corneal surfaces showed any significant change.

In the second set of analyses, we examined the effect of baseline values of different parameters on the amount of 3-month changes in the studied aberrations. With univariate regression analyses, baseline CCT significantly impacted changes in total RMS HOA ($\beta = 0.009$, $p = 0.017$), anterior surface 3rd order coma 90° ($\beta = -0.010$, $p = 0.034$), and anterior surface 4th order astigmatism 0° ($\beta = 0.002$, $p = 0.029$). CCT relationships with total RMS HOA and anterior 4th order astigmatism 0° retained their significance in the multiple model as well ($\beta = -0.841$, $p = 0.001$ and $\beta = 0.003$, $p = 0.045$, respectively). Also, changes in anterior spherical aberration ($\beta = -0.525$, $p = 0.005$), 2nd order astigmatism 45° ($\beta = -0.321$, $p = 0.018$), and 4th order astigmatism 45° ($\beta = -0.279$, $p = 0.014$) significantly related with their baseline values; the second relationship retained its significance in the multiple model ($\beta = -0.313$, $p = 0.045$) and is illustrated in Fig. 1. No other significant relation was found between changes in any of the aberration variables and baseline maximum keratometry reading, CCT, or anterior Q-value (all $p > 0.05$).

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