RESEARCH NOTE

Temporal evolution of the corneal curvature in contact lens wearers

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Summary

In the present work, we have measured the corneal radii in a group of 126 healthy subjects, studying the temporal evolution of these radii after adaptation to contact lenses of polyhydroxyethyl methacrylate with 55% hydration. We measured the horizontal and vertical radii before adaptation, as well as after 3, 6 and 9 months of wearing contact lenses. The decreases were not significant ($P < 0.05$) in the corneal radii of these subjects; maximum decreases were reached the day after wearing contact lenses, with subsequent recuperation, such that at 9 months the decreases, though persisting, were minimal. Copyright © 1996 The College of Optometrists. Published by Elsevier Science Ltd

Introduction

In adaptation to contact lenses, the determination of corneal radii is highly important because, from these measurements, is chosen the radius of curvature of the posterior optic zone for the first trial contact lens (Sarver et al., 1984).

In addition, the corneal surface cannot be considered absolutely rigid because, with a certain plasticity, it tends to change its shape. Consequently, the adaptation to contact lenses can (directly or indirectly) affect adjacent structures, thus altering the physiology of such tissues (Velasco et al., 1993; Velasco, 1994).

The objective of our work has been to study the curvature radii of the anterior side of the cornea, in a group of healthy subjects before and after adaptation to contact lenses, in order to determine the changes in the corneal radii over time. The adaptation time for the lenses was 8 h per day.

Materials and methods

Of the 126 subjects studied, 86 were women and 40 men. The women averaged 23 years of age, with a range of 14–32 years; the men averaged 21 years, with a range of 15–26 years.

The contact lenses used were turned lenses made of polyhydroxyethyl metacrylate, for daily use, with a hydration of 55% and axial thickness of 1 mm. The total diameter, curvature radius and thickness of the contact lenses were appropriate according to the measurements of the horizontal diameter of the visible iris, corneal radius and refraction defect of each subject, respectively. We verified that the fitting of the lenses was correct by using a keratometer and streak retinoscope. In addition, we verified the correct centring over the corneal surface by using a biomicroscope.

The measurements were taken with a Javal keratometer (Velasco et al., 1992), which forms virtual images, upright and smaller in size, upon the anterior surface of the cornea. The cornea, being covered by a tear film, acts like a convex mirror. The tear film adheres by capillary action to the epithelial cells of the cornea, reflecting the light and acting on the object of the keratometer, which then forms the second image of the mire within the apparatus. This image is received by the eyepiece and finally forms the image perceived by the observer (Weinstock, 1989).

The measurements were taken on the corneal apex, from the horizontal meridian, followed by the vertical meridian. We measured the values for the meridians in mm, and calculated the refractive power ($F'$) by the formula of the air–cornea dioptrix (Gil del Rio and Baronet, 1980):

$$F' = \varphi' n'$$

where:
\( \varphi' \) = image power of the cornea–air dioptric; 
\( n' \) = air refractive index.

The contact lenses were fitted to the subjects at 9 a.m. and, after 8 h the corneal radii were measured. These measurements were made for the same observer, the day after fitting, at 90, 180 and 270 days. The measurements were compared with those taken before the fitting of the lenses in the same subjects. The calibration of the keratometer was checked for the same observer each time before taking the measurements.

The results were analysed statistically using the BMDP program. IBM PC-386/MS-DOS, 1990 version. In all of the comparisons of hypotheses, we found a significance level of \( P = 0.05 \), normal for this type of analysis.

Results and discussion

Both the men and the women presented spherical ametropia in each eye. The spherical refraction error for the right eye was between \(-0.50\) and \(-5.00\) D, with \(-1.50\) D being the most frequent (17.5%), followed by \(-2.00\) D (15.9%). For the left eye, the refraction error was between \(-0.75\) and \(-5.25\) D and, within this, \(-1.50\) D proved to be the most frequent (15.7%), followed by \(-3.00\) D (12.7%).

The measurements for the horizontal and vertical radii of the subjects before adaptation to the contact lenses are presented in Table 1. The larger and smaller measurements for the horizontal corneal radius are 8.64 mm and 7.30 mm, respectively, while for the vertical the two values were 8.60 mm and 7.22 mm, respectively.

The horizontal meridian was slightly greater than the vertical, although this difference was not significant \( (P > 0.05) \). This result is corroborated by Amat (1985), who demonstrated that corneas were spherical in newborns, whereas at four years old 68% stigmatism develops, with 95% at seven years old. We consider this stigmatism to be physiological, and it could be caused by the pressure exerted on the eye by the upper eyelid. Figure 1 shows the average decrease of the horizontal corneal radii in women before adapting to contact lenses and after adaptation of the first day, 90, 180 and 270 days. The decreases in the vertical corneal radii of the women are represented in Figure 2. Similar to the horizontal radii, the decrease is greater after one day and minimal after 270 days. For women, a decrease without statistical significance \( (P > 0.05) \) was detected in the horizontal and vertical radii before and after adaptation to contact lenses \( (Figures\ 1\ and\ 2) \); the same results were found for men \( (Figures\ 3\ and\ 4) \).

In both sexes the reduction of the corneal radius was greater the first day and partially recuperated so that after 270 days the decrease was minimal.

In 1992, Young and Port carried out a comparative clinical study on rigid gas-permeable contact lenses and soft contact lenses of extended use. Measuring the cornea, these researchers found a decrease of 0.13 mm in the radii of curvature in the wearers of rigid gas-permeable contact lens wearers. In the same year, Kok et al. also observed significant changes in corneal curvature after three months of wearing the rigid contact lenses.

In contrast to Young and Port, we recorded a decrease in the corneal radii one day after the fitting of the contact

### Table 1. Horizontal and vertical corneal radii (mm) before wearing contact lenses, measured at 5 p.m.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Shortest measurement</th>
<th>Longest measurement</th>
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<tr>
<td>HCR.RE</td>
<td>Women</td>
<td>7.87</td>
<td>0.03</td>
<td>7.40 8.42</td>
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<tr>
<td>Men</td>
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<td>0.04</td>
<td>7.61 8.45</td>
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<td>VCR.RE</td>
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<td>0.03</td>
<td>7.30 8.40</td>
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<tr>
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<td>7.97</td>
<td>0.04</td>
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<td></td>
</tr>
<tr>
<td>HCR.LE</td>
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<td>7.87</td>
<td>0.04</td>
<td>7.30 8.31</td>
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<td>8.05</td>
<td>0.06</td>
<td>7.62 8.64</td>
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<td>7.22 8.31</td>
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<tr>
<td>Men</td>
<td>8.03</td>
<td>0.04</td>
<td>7.59 8.60</td>
<td></td>
</tr>
</tbody>
</table>

Horizontal corneal radii of the right eye (HCR.RE) and left eye (HCR.LE); vertical corneal radii of the right eye (VCR.RE) and left eye (VCR.LE); standard deviation (SD).

**Figure 1.** Decreases in the horizontal corneal radii (HCR) in millimetres for women, before wearing contact lenses, and after one day of use, 90, 180 and 270 days of use in the right eye (RE) and left eye (LE).
Figure 2. Decreases in the vertical corneal radii (VCR) in millimetres for women, before wearing contact lenses, and after one day of use, 90, 180 and 270 days of use in the right eye (RE) and left eye (LE).

Figure 3. Decreases in the horizontal corneal radius (HCR) in millimetres for men, before wearing contact lenses, and after one day of use, 90, 180 and 270 days of use in the right eye (RE) and left eye (LE).

Figure 4. Decreases in the vertical corneal radius (VCR) in millimetres for men, before wearing contact lenses, and after one day of use, 90, 180 and 270 days of use in the right eye (RE) and left eye (LE).

lenses. However, with time, there was a gradual recuperation of this parameter, so that after 270 days the decrease of the corneal radius was very slight (0.07 mm).

In 1979, Rengstorf, studying 50 wearers of soft contact lenses, found a mean increase in myopia of 0.37 D after 3 months and a decrease in the curvature radius of 0.07 mm. According to this author, myopization can be caused not only by a change in the curvature of the anterior corneal surface, but also by variations in the posterior corneal radius, corneal thickening and refraction index (Rengstorf, 1979a, b).

We demonstrated a mean decrease in the horizontal and vertical corneal radii, respectively, of 0.10 mm and 0.11 mm, one day after fitting of the lenses, and a mean increase in myopia of 0.56 D. After 90 days, the mean decrease of the horizontal and vertical radii, respectively, was 0.05 mm and 0.06 mm, with an increase in myopia of 0.31 D. After 180 days, the variation in radii was 0.02 mm and 0.03 mm, with a decrease in myopia of 0.14 D; finally, at 270 days, the radii decreased 0.01 mm and 0.02 mm, with a myopia increase of 0.10 D.

Our results confirm the findings of Rengstorf with regard to the increased myopia in these subjects. We suspect that the cause of these findings is corneal moulding, possibly caused by the pressure of the eyelid on the cornea.
Conclusion

The measurement of the corneal radii before and after fitting of the contact lenses in a group of 126 subjects indicated mean decreases in the horizontal and vertical corneal radii of 0.105 mm after the first day of fitting the lenses and of 0.055, 0.025 and 0.015 mm after 3, 6 and 9 months, respectively. These differences are significant in relation to the measurements of the corneal radius taken one day before fitting the contact lenses. Therefore, we demonstrated a non-significant decrease (P > 0.05) in the corneal radii of these subjects, which was maximum on the second day of wearing lenses, recuperating afterwards to such a degree that after 9 months the decrease in the corneal radius, while still discernible, was minimal.

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References


