Corneal thickness response to high and low water content lenses in aphakic eyes

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SUMMARY A high water content lens (Scanlens 75, +14.5 dioptres) and a low water content lens (Bausch and Lomb Soflens H3, +14.5 dioptres) were compared with respect to corneal thickness response after 6 hours of wear in a provocative test on 12 aphakic eyes. The mean increase in central corneal thickness was 3.3% for Scanlens and 6.4% for Soflens. This difference is statistically highly significant (p<0.001). There seems to be a correlation between the response to Scanlens and that to Soflens when the responses of each eye were plotted against each other. Average lens thickness correlated somewhat better with corneal thickness increase than did central lens thickness.

The rather thick hydrophilic contact lenses used in aphakia do not give rise to corneal oedema to an extent expected on the basis of their low values for oxygen transmissibility. What causes this difference between corneas of aphakic and phakic eyes is not fully known, but it might be related to a lower rate of epithelial oxygen uptake and a thinner endothelium of the cornea in the former eyes than the latter.

Though the cornea of the aphakic eye tolerates a contact lens better than that of a phakic eye, it is still of importance to choose lenses that do not cause excessive oedema. In the present investigation high water content and low water content lenses were compared in a provocative test with respect to corneal swelling in aphakic eyes.

Material and methods

The study was carried out on 12 unilaterally aphakic patients, 7 females and 5 males, aged 30 to 75 years (mean 58 years). They all underwent cataract surgery without complications between 2 and 4 months prior to the study. In no case was phakoemulsification employed. Both eyes of each patient were free of earlier or apparent disease except for incipient cataract of the phakic eye. No patient had any general disease that might influence the eye. On the basis of clinical examination all patients were found suitable for contact lens wear.

Central corneal thickness was measured with a Haag-Streit slit-lamp and pachometer with a digital output allowing readings at the level of microns. To ascertain that measurements were performed at the centre of the cornea an alignment system according to Donaldson was employed. Each measurement session included 22 readings per eye. The largest reading and the smallest reading were omitted, and the mean of the remaining 20 readings was calculated. Student’s t-test was used to calculate statistical significances. Initial measurements of corneal thickness of both eyes were performed between 9.30 and 10.15 a.m. after the patients had been awake for at least 2 hours. A Scanlens 75 (approximately 72% water) contact lens, +14.5 dioptres and 13.5 mm in diameter, was then fitted on the cornea of the aphakic eye. The back surface radius of the lens being approximately 0.3 mm flatter than the highest keratometer reading (8.1, 8.3, and 8.5 available). After 6 hours of wear the lens was removed and both eyes were measured with respect to corneal thickness as above. The phakic eye being used as a control.

On a second day, one to 4 days later, the same programme was repeated with a Bausch and Lomb Soflens H3 (approximately 39% water) contact lens. +14.5 dioptres. and 13.5 mm in diameter, with a back surface radius of 8.3 mm (only one back surface radius is available).

Every lens employed in the study was measured with respect to centre thickness with an electronically
coupled micrometer device. The average lens thickness was calculated after the cross-section of each lens had been measured at 20 equidistantly spaced points by means of shadow projection and a screen. The mean values for centre thickness and average thickness of the Scansens contact lenses used were 0.58 mm and 0.33 mm respectively, and for the Soflens contact lenses 0.60 mm and 0.28 mm respectively.

Results

At the initial examinations the corneal centre of the aphakic eyes was found to be 1.39±0.36% (mean and standard error of mean) thicker, on the average, than that of the phakic eyes. This difference was not statistically significant, however.

After 6 hours of lens wear the mean increase in central corneal thickness of the aphakic eyes was 3.29±0.19% for Scansens and 6.38±0.44% for Soflens (Fig. 1). This difference is statistically highly significant (p<0.001). The phakic control eyes showed a mean increase in central corneal thickness during the 6 hours of only 0.06±0.08%.

When increase in corneal thickness after wear of Scansens 75 was plotted against that after wear of Soflens for each eye (Fig. 2) a correlation was observed.

Discussion

The study shows, as might be expected, that the high water content lenses gave rise to significantly less corneal oedema than the low water content lenses. For each eye there seemed to be a correlation between the corneal response to high water content lenses and that to low water content lenses. This in turn would imply that the response of a given cornea is at least roughly proportional to the disturbance of corneal metabolism caused by a contact lens.

In absolute figures the increase in thickness of the corneal centre of the aphakic eyes in response to contact lens wear was less than would be expected for phakic eyes. This is in agreement with the findings of earlier authors. Using the same low water content material as in the present investigation (Soflens), but slightly thinner (F3, centre thickness 0.51 mm), Holden et al. found an increase in corneal centre thickness of 5.1% for aphakic versus 9.7% for phakic eyes after 6 hours of lens wear, a statistically significant difference (p<0.005).

The cause of this difference has been discussed. Holden et al. showed that the oxygen uptake rate of corneal epithelium was 15% lower in aphakic than in phakic eyes (p<0.01). Furthermore, the corneal endothelial cells are fewer, and thus the endothelium thinner, in aphakic than in phakic eyes. Guillon and Morris found 16% fewer cells, a statistically highly significant difference, and Holden et al. 18% fewer cells, p<0.025. Since it is an increased rate of
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production of lactic acid, and thus an increased corneal osmolarity, that is considered to cause corneal oedema as a response to hypoxia.\textsuperscript{10,11} the difference between aphakic and phakic eyes could be related to a reduction in corneal epithelial metabolism or to an increased endothelial permeability to lactate in aphakic eyes.\textsuperscript{5}

For the present investigation standard power lenses were chosen rather than standard thickness lenses, because this is what one would have to do in clinical practice.

The mean difference in centre thickness between the 2 lens types was small, about 3.5\%. Since the oxygen permeability of Scanlens 75 material is about 3.5 times that of Soflens material (J. A. Morris, unpublished observation), the oxygen transmissibility of the central area of the 2 lens types will differ by about the same extent. Corneal swelling after Soflens was only about twice that after Scanlens, however. When average lens thickness of the 2 lens types was compared, it was found that the Soflens lenses were approximately 18% thinner than the Scanlens lenses. Thus, average lens thickness correlates somewhat better than centre lens thickness with corneal thickness response. This is in agreement with the findings of B. A. Holden (personal communication).

The clinical conclusions are that Scanlens 75 contact lenses of powers and thicknesses employed in the present study can be safely used in aphakia with respect to corneal response, whereas in this provocative test Soflens H3 contact lenses gave rise to significantly more corneal oedema. Even for lenses of powers and thicknesses correcting low-degree myopia it has been shown earlier\textsuperscript{12} that corneal swelling was less for Scanlens 75 lenses than for Soflens lenses, but this difference becomes more important with thicker lenses. Finally it might be pointed out that Scanlens 75 lenses are rigid enough to permit daily wear and not only extended wear.

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