

Corneal thickness in extended wear of soft contact lenses

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SUMMARY The continual wearing of a soft contact lens for a period of 20 weeks is shown to produce no significant evidence of corneal swelling, although the use of soft lenses in conjunction with a topically applied solution is shown to produce evidence of transient swelling. The extent of corneal thinning during waking hours is also shown to be reduced among wearers of contact lenses for long periods.

Some corneal swelling invariable accompanies the wearing of contact lenses (Mandell and Polse, 1969). Such swelling is usually provoked by a disturbance to the available oxygen supply (Hill and Cuklanz, 1967), though other factors may also influence the cornea (Kempster and Larke, 1978).

In the present study the thickness of the cornea of patients wearing contact lenses without removal for a period of 20 weeks was examined. During the study it was intended to distinguish between those effects which were solely attributable to extended contact lens wear, and those effects which were attributable to extended lens wear in conjunction with proprietary solutions, as recommended by at least one manufacturer (Ganju, personal communication). For this reason 2 groups of lens-wearing subjects were examined in conjunction with a control group of non-lens wearers.

Patients and methods

Fifty-seven volunteer Caucasian subjects who came within a previously determined acceptance profile were assembled. One-third (the non-solution users' group) were fitted with a hydrogel lens manufactured from a copolymer of vinyl pyrrolidone and methyl methacrylate (Saufion PW, manufactured by Contact Lens Manufacturing Ltd.). A further third (the solution users' group) were fitted with similar lenses that were removed and cleaned overnight at 8-week intervals with a proprietary cleaning agent (Monoclen and Monoclen C40, manufactured by Contact Lens Manufacturing Ltd.). In addition the solution users also instilled 1 drop of proprietary buffered saline on waking and before retiring each

day (Sterilet, manufactured by Contact Lens Manufacturing Ltd.). The remaining third retained their spectacles and acted as controls.

At the 16th week of the study the right eyes of 7 volunteers from each group were monitored for change of corneal thickness during the period of 1 waking day (0900 to 2000 hrs). Corneal thickness measurements at 9 corneal locations (central: 15° and 30° in the vertical and horizontal meridians) were made with the aid of a self-recording topographic pachometer (Hirji and Larke, 1978).

The results from the pachometer were collected 'blind' by means of a tape printer. As the purpose of the study was to examine trends in the collected data, the readings were directly analysed instead of having a correction factor applied for an assumed corneal refractive index and a compensation factor for individual variations in corneal curvature. Hence the pachometer readings are given as 'apparent corneal thickness'.

A Latin square appointment system was used throughout the study, which ensured that each subject was examined once, at all appointment times, thus enabling the mean time of measurement to be kept constant for all subjects.

Results

TWENTY-WEEK STUDY

The analysed data for the 3 groups of patients showed a statistically significant ($P=0.01$) pattern, which was equally reflected in all corneal regions. The results and regression equations for the central region of the cornea are shown in Fig. 1.

WAKING-HOURS STUDY

The results from the 3 groups of patients showed a statistically significant ($P=0.01$) thinning of the

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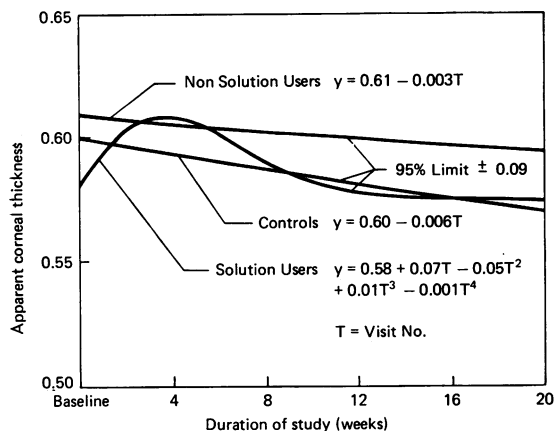


Fig. 1 Human corneal thickness (central region) during a period of extended contact lens wear

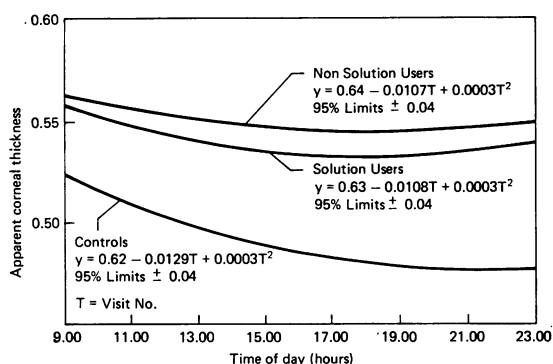


Fig. 2 Human corneal thickness (central region) during waking hours

cornea. The pattern of thinning was equally reflected in all corneal regions, and the results and regression equations for the central corneal region are shown in Fig. 2.

Discussion

TWENTY-WEEK STUDY

The results for the control and non-solution users' group indicate, a slight (4%) regular reduction in corneal thickness during the progress of the study. At present we have no entirely satisfactory interpretation for this result. The pachometer was

calibrated before, during, and at the completion of the study, and the data, which were collected 'blind' by means of a tape printer, showed no evidence of operator or instrumental bias. The study was conducted from January to June, and a seasonal variation may be plausible. However, it remains for further long-term work to investigate this possibility.

The data for the solution users' group show a pattern of transient swelling followed by a return to the prefitting norm. The absence of a similar pattern in the non-solution data suggests that the transient swelling is attributable to the solution used rather than to the presence of the contact lens. The solution used was 0.9% buffered saline, which was instilled daily. Hill and Terry (1978) have recently demonstrated the equivalent tonicity of the precorneal tear film to be 0.97%. Our currently preferred interpretation of the solution users' results is that the swelling was induced as a result of the change in tonicity commensurate with the instillation of saline. A check of stock records showed that no further saline was issued after the 10th week of the study, while an examination of returned patient questionnaires showed that the patients received no subjective benefit from the solution after an initial period and spontaneously gave up using them.

WAKING-HOURS STUDY

The results for the control subjects show a reduction in corneal thickness of approximately 8% during the waking day, while both groups of patients wearing contact lenses show a change of just under 3%. There is also an apparent difference between the initial values for the control and experimental groups, the experimental groups being some 5% thicker. An examination of prefitting values for all groups of subjects shows this difference to have arisen through a chance distribution between the groups rather than as a result of wearing contact lenses.

Our preferred interpretation of the difference in the extent of thinning between the groups is that it is due to the influence of the volume of water in the lens on tear tonicity levels. The change in tear tonicity as a result of evaporation has been held to be responsible for the rapid thinning of the cornea on lid opening (Mishima and Maurice, 1961; Mandell, 1965).

The influence of contact lens water volume on tear tonicity levels is summarised in Table 1. Hence

Table 1 Influence of contact lens water volume on tear tonicity levels

	Volume of tears (μ l)	Volume of water in lens (μ l)	Tear loss through evaporation	% Change in fluid volume on the eye	Calculated tear tonicity (% NaCl)
Non-soft lens wearer	7 ¹	Nil	0.5 ³	7	0.96
Soft lens wearer	7 ¹	Approx. 40 ²	0.5 ³	0.96	0.91

¹Mishima (1965). ²Authors' measured value. ³Calculated from Mishima (1965).

among soft lens wearers tonicity provoked corneal thinning may be substantially absent, while slower changes attributable to other, as yet undetermined mechanisms may be seen (Kikkawa, 1973).

Conclusion

An examination of corneal thickness in wearers of contact lenses for extended periods shows a surprising absence of corneal swelling when contact lenses alone are used. However, the use of such lenses in conjunction with a topically instilled solution is shown to produce evidence of transient swelling, and it is probable that the role, and particularly the composition, of such solutions should be carefully examined. The degree of change in corneal thickness during waking hours is shown to be reduced for subjects wearing one type of high-water-content lens.

These results suggest a generally favourable level of physiological compatibility for this type of hydrogel contact lens worn through periods of sleep, and also emphasise the role of tear tonicity in passive corneal homeostasis.

The authors thank those members of staff and students of the University of Aston who participated in this study.

We would also like to thank Mr C. Peaston, senior

electronics technician, for construction of the apparatus, and we are grateful to Contact Lens Manufacturing Ltd. for the supply of contact lenses, and for the financial support of one of us (N. K. H.).

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Br J Ophthalmol 1979 63: 274-276

doi: 10.1136/bjo.63.4.274

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