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Changes in the Corneal Endothelium of Aphakic Patients Following Extended Soft Contact Lens Wear

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ABSTRACT. The contact lenses used for visual correction of aphakia are mostly soft contact lenses for extended wear because most aphakic patients are elderly. The effects of extended wear of such contact lenses on corneal endothelial cells have been recently reported. In this study, two groups, an extended wear SCL group and a spectacles group, were compared with respect to various parameters by means of specular microscopy following surgery for cataract.

The SCL group consisted of 16 subjects and 16 eyes. The average age at operation was 67.8 years and the wearing period was 1 to 5 years after operation. The spectacles group consisted of 14 subjects and 16 eyes; the average age at operation was 70.1 years, and the wearing period was 1 to 5 years after surgery. Using a wide field specular microscope (model SP-1), endothelial cells in the central part of the cornea were observed and photographed. The endothelial cell picture was then enlarged to a final magnification of 450 times, and the image was analyzed using the KC-8VA cell analyzer system.

There was no significant difference in the mean cell area (μm^2) and mean cell density (cell counts/mm^2) between the two groups, but the coefficient of variation (CV) was significantly elevated in the SCL group after operation. The percentage of hexagonal cells was also significantly lower in the SCL group after operation.

Therefore extended wear of soft contact lenses appears to make corneal endothelial cells unstable and accelerates changes in corneal endothelial cells due to aging.

Key words : corneal endothelium — aphakia — soft contact lens — specular microscopy — coefficient of variation

The contact lenses used in the correction of visual acuity in aphakic patients are mostly worn for an extended period, chiefly because the majority of the patients are elderly. Recently, however, more attention has been paid to the effects of extended use of contact lenses on corneal endothelial cells. Accordingly, we compared the changes in corneal endothelial cells in two groups, a group wearing soft contact lenses with a high water content after cataract surgery and a group wearing spectacles.

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SUBJECTS AND METHODS

The subjects were patients having no factors that might affect the corneal endothelium either before or after operation (diabetes mellitus, uveitis, glaucoma, or complications during or after operation). The surgical technique was intracapsular cryo extraction in all cases. Sixteen patients wore soft contact lenses in 16 eyes. Their average age at the time of operation was 67.8 years, and period of use ranged from 1 to 5 years after operation. Fourteen patients wore spectacles in 16 eyes. At the time of operation, they were aged 70.1 years on the average and the period of use was 1 to 5 years after operation.

All soft contact lenses had a water content of 78%.

The photographic apparatus was a wide field specular microscope model SP-1 (manufactured by Konansha). Pictures were taken of the central part of the cornea, and the image of the endothelial cells was magnified to 450 times. The photographs were analyzed by a cell analyzer system (model KC-87A, Konansha).

The following parameters were studied: 1) mean cell area (μm^2), 2) mean cell density (cells/mm^2), 3) the coefficient of variation (CV), and 4) the rate of incidence of hexagonal cells (%).

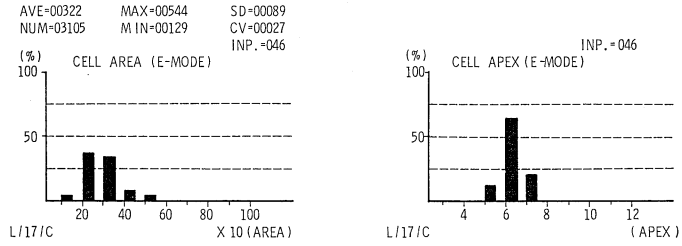

Fig. 1. Corneal endothelial cell analyser system

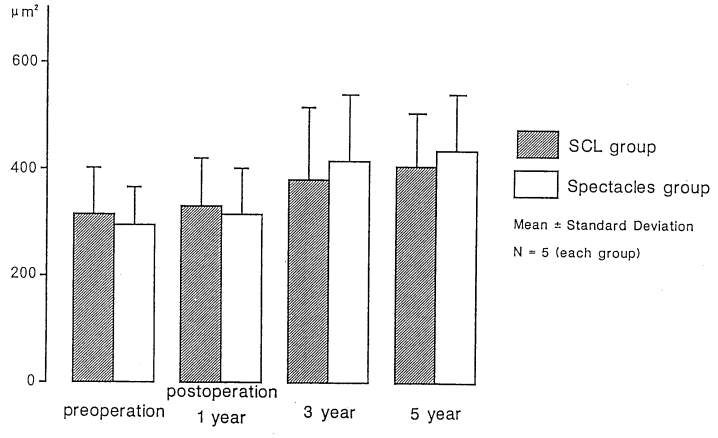

Fig. 2. Endothelial cell density (μm^2)

RESULTS

The mean cell area (μm^2) (mean ± standard deviation) in the soft contact lens group (SCL group) was 313.0±86.9 before operation, 330.4±90.4 at 1 year after operation, 382.6±139.1 at 3 years, and 405.2±182.6 at 5 years. In the spectacles group (SP group), it was 295.7±69.5 before operation, 323.5 ±86.9 at 1 year after operation, 417.4±121.7 at 3 years, and 434.8±104.3 at 5 years. There was no significant difference between the two groups at any period.

The mean cell density (cells/mm^2) was 3,236±581 before operation, 2,653 ±645 at 1 year, 2,585±574 at 3 years, and 2,521±693 at 5 years in the SCL group, and was respectively 3,320±442, 2,732±502, 2,705±534, and 2,672±497 in the SP group. At no time was there any significant difference between the groups.

The CV value was 0.284±0.019 before operation, 0.336±0.049 at 1 year, 0.432±0.097 at 3 years, and 0.448 at 5 years in the SCL group. It was 0.268±0.021 before operation, 0.281±0.028 at 1 year, 0.292±0.032 at 3 years, and 0.276±0.031 at 5 years in the SP group. Thus, the CV value was significantly elevated 1 year after operation in the SCL group ($p<0.05$), and was also significantly elevated after 3 years and 5 years ($p<0.01$).

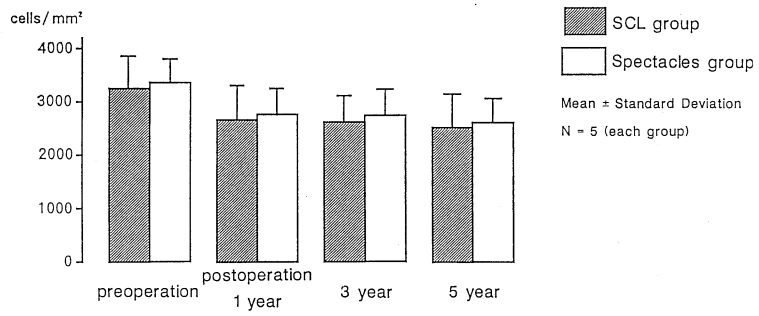

Fig. 3. Mean cell size (cells/mm^2)

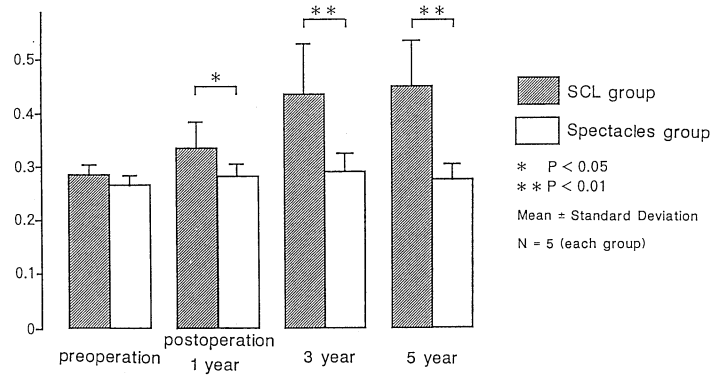

Fig. 4. Coefficient of variation of endothelial cell (CV value)

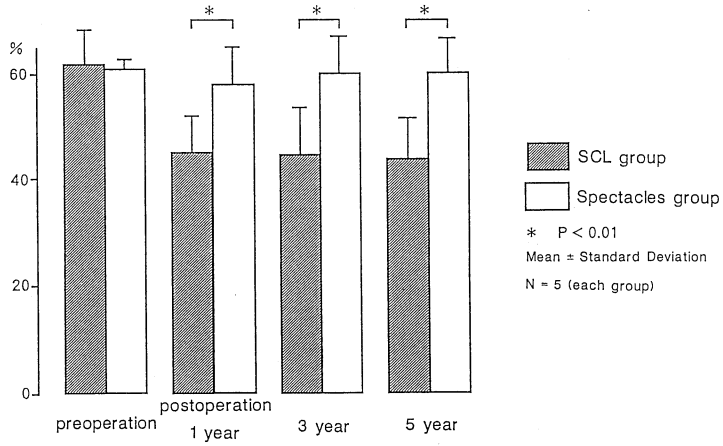

Fig. 5. Frequency of hexagons (%)

The rate of incidence of hexagonal cells (%) was 62.2±6.7 before operation, 46.5±6.7 at 1 year, 45.2±8.7 at 3 years, and 44.2±7.8 at 5 years in the SCL group, and was respectively 61.7±5.7, 57.5±6.7, 60.0±6.5, and 59.8±6.0 in the SP group.

Thus, the rate of incidence of hexagonal cells was significantly lowered after 1, 3 and 5 years in the SCL group ($p<0.01$).

DISCUSSION

The corneal endothelium is a layer of cells consisting of about 500,000 cells in youth. The cell numbers decrease due to aging or injury, and mitosis rarely occurs, but losses are replaced by expansion of the adjacent cytoplasm.[1]

Since specular microscopy has come into use in the observation of corneal endothelial changes due to ocular operations such as vitrectomy, a decrease in endothelial cell numbers and the onset of polymorphism have been reported.[2]

Recently, changes in corneal endothelial cells due to the wearing of contact lenses have been noted. Elevation of the CV of corneal endothelial cells[3] and a decrease in hexagonal cells[4] due to PMMA contact lenses have been reported. The mechanism of onset of changes in the corneal endothelium due to the wearing of contact lenses is regarded as chronic oxygen deficiency.[4] The supply of oxygen to the corneal endothelium depends mainly on oxygen from the aqueous humor, in contrast to the substantial oxygen conveyance from the atmosphere to the epithelial surface. It has been reported that the oxygen level was lowered in the aqueous humor of monkeys wearing hard contact lenses. In one study, when a normal human corneum was experimentally placed in a hypoxic state, abnormalities were induced in the corneal endothelial cells and oxygen deficiency appears to have had a strong influence on the corneal endothelium.[4]

With soft contact lenses, extended wear is also reported to cause changes in the corneum[5] or to induce variations in corneal endothelial cells, although no change has been observed in corneal endothelial cell density.[6,7]

Fig. 6A. Endothelial photograph of a preoperative eye with senile cataract (87-year-old man)
Endothelial cell density 2415 cells/mm² Mean cell size 414 μm^2
CV value 0.27 Frequency of hexagons 66.7% — 100 μm

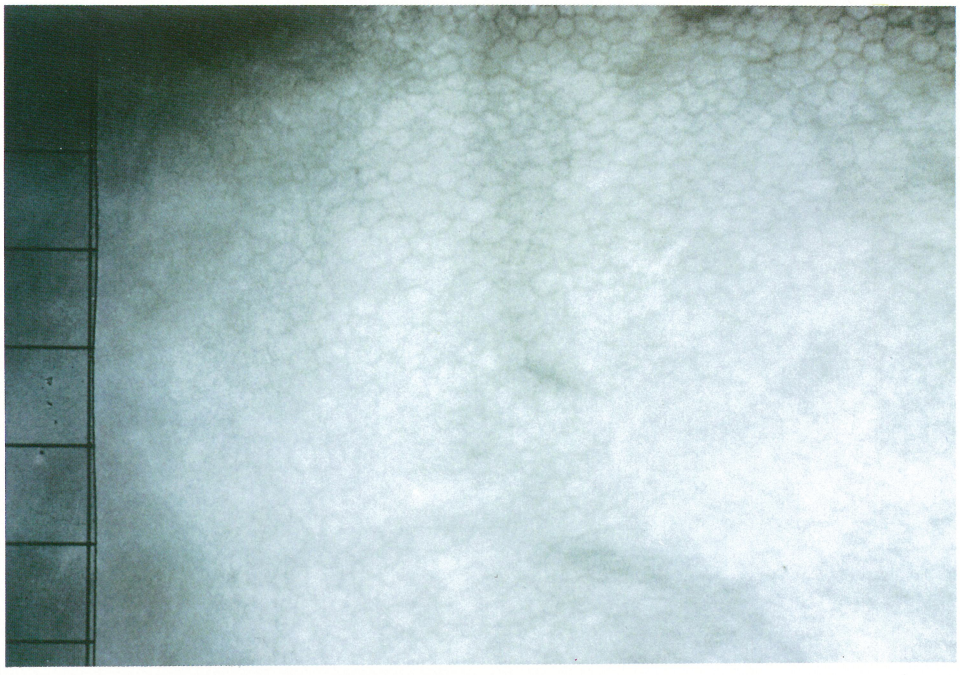

Fig. 6B. Endothelial photograph of a lens-wearing eye 2 years after cataract surgery
Endothelial cell density 1760 cells/mm² Mean cell size 568 μm^2
CV value 0.32 Frequency of hexagons 53.6%

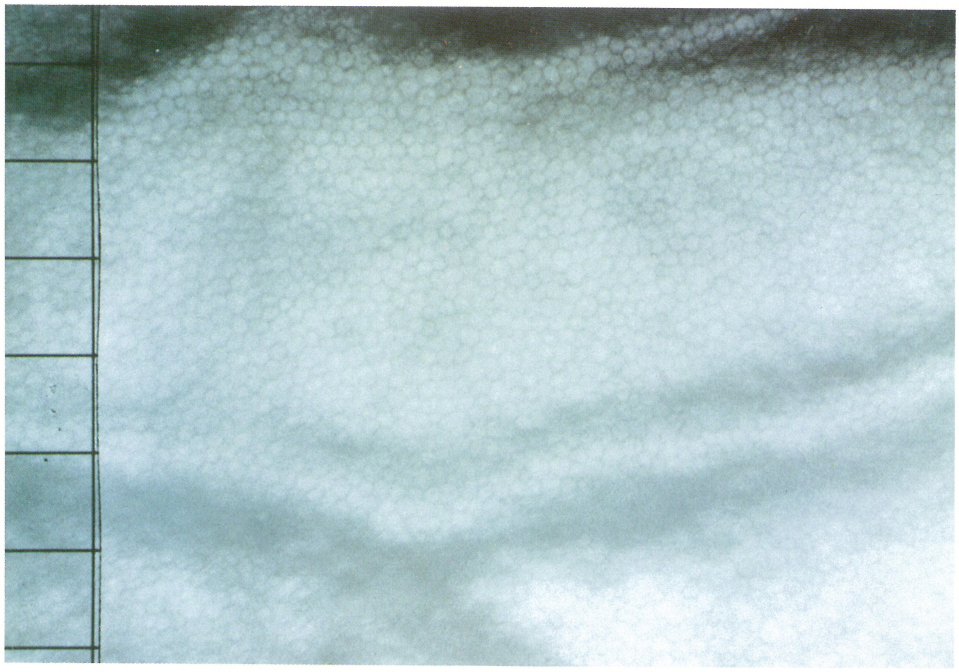

Fig. 7A. Endothelial photograph of a preoperative eye with senile cataract (63-year-old man)
Endothelial cell density 3105 cells/mm² Mean cell size 322 μm^2
CV value 0.27 Frequency of hexagons 61.9% — 100 μm

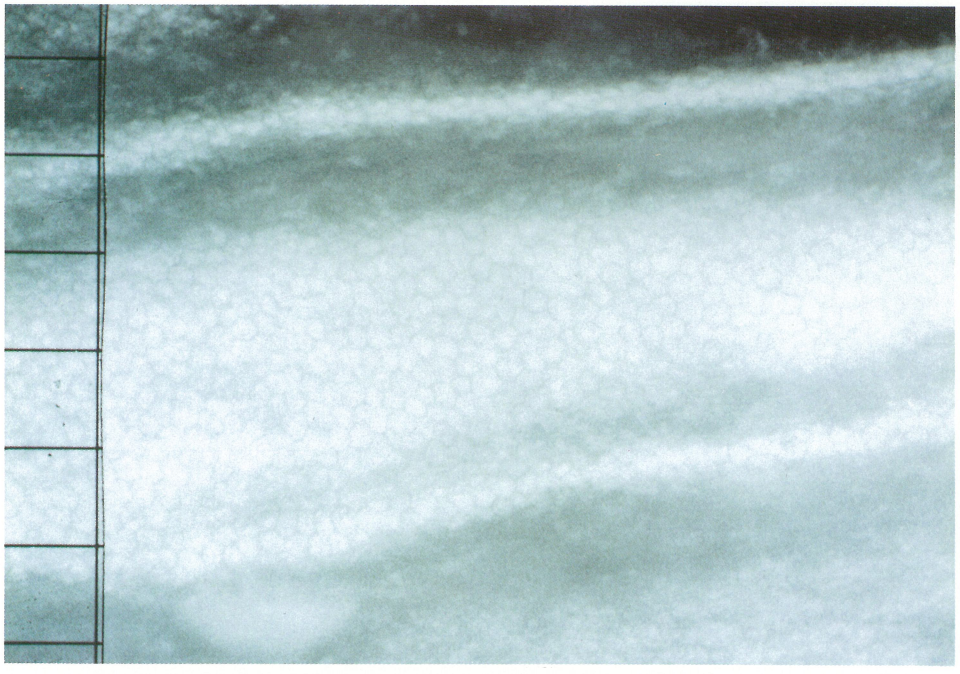

Fig. 7B. Endothelial photograph of a non-lens-wearing eye 1 year after cataract surgery
Endothelial cell density 2236 cells/mm² Mean cell size 447 μm^2
CV value 0.24 Frequency of hexagons 61.9%

As for the effects of the extended wearing of contact lenses on the corneum in aphakic patients, although there has been no change in the size of corneal endothelial cells,[8] elevation of the CV value and loss of hexagonal cells have been noted.[9]

To correct visual acuity in aphakic patients, contact lenses are mostly used in elderly patients. The majority of these are soft contact lenses designed for extended wear. In the present study, for the correction of visual acuity after surgery for senile cataract, either soft contact lenses for extended wear or spectacles were used, and changes in the corneal endothelium were comparatively studied between the two groups. In the contact lens group, elevation of the CV value and the loss of hexagonal cells were noted. These results agreed with previous reports. Our study differed from previous ones,[8,9] however, in that the operations were conducted by one surgeon and the intracapsular extraction technique was used, with the purpose of making uniform the effects of the operation itself on the corneal endothelium. It appears that the extended wearing of soft contact lenses after cataract surgery is one of the factors reducing the supply of oxygen to the corneal endothelium, thus rendering the endothelial cells unstable and accelerating changes due to aging. The development of better soft contact lenses is thus necessary.

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