Abstract

Aim: To reveal the changes of corneal endothelial characteristics with aging among Caucasian population.

Methods: Non-contact specular microscopy was performed in 564 eyes of 282 healthy Caucasian Turkish patients. Endothelial cell density (MCD), mean cell area (MCA), coefficient of variation (CV) in cell size, percentage of hexagonal cells, and central corneal thickness (CCT) were measured.

Results: The mean age was 42 ± 17.1 (6–85) years. The MCD of the population was 2732 ± 305 cell/mm² (range, 1904–3802 cell/mm²). The MCA was 368 ± 41 m² (range, 263–522 m²). The mean CV in cell size was 34 ± 7 (range, 25–76%), the mean percentage of hexagonal cells was 46 ± 8% (range, 25–76%), and CCT was 513 ± 39 (range, 407–623). There was statistically significantly negative correlation (p < 0.05) between age and cell density, hexagonality, and pachymetry. There was statistically significant correlation (p < 0.05) between age and MCA.

Conclusion: We report the normal values of corneal endothelial characteristics in Caucasian Turkish eyes. Over the age of 20, the MCD of Caucasian eyes is more than the Indian and Iranian eyes and less than the Chinese eyes. Caucasian population’s cell density in under the age of 20 is 3101 ± 268 cell/mm².

Keywords: Corneal endothelium, Cell density, Specular microscopy

Introduction

For a clear vision in a healthy cornea, the number of endothelial cells covering the back surface of the cornea should be sufficient.¹,² Due to the fact that cornea is incapable of mitosis, the number of cells diminishes because of several factors such as aging, trauma and surgery.³,⁴ In parallel, there occurs efforts to compensate the decreasing number of cells with enlargement of healthy endothelial cells and reduction in their hexagonality.³–⁶ The average number of endothelial cells and other parameters of endothelium in healthy subjects belonging to most ethnic groups, was reported to have been altered with aging in various studies. In this study we aimed to observe the changes in endothelial cell features and the number of endothelial cells in the Caucasian population.

Materials and methods

We evaluated the 564 eyes of 282 subjects (137 females and 145 males) whose ages were between 6 and 85 that accepted to participate in our study voluntarily after they were informed about the procedures within the scope of

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in cell shape (polymorphism). It has become easier to try to assess this variability by reporting on the polymegathism (variability in cell areas) and/or the polygonality (variability in the number of cell sides). The polymegathism has attracted the most attention. The index of polymegathism, which is usually reported as a percentage, has been reported as the CV on the cell areas that were measured. It is also possible to grade polymegathism with the help of sets of representative images or schematics.

Data analysis was performed using SPSS software (version 16.0, SPSS, Inc.). Mann–Whitney U test was used. Spearman Correlation was used to examine the change in endothelial cell characteristics with age. Data are shown as mean ± standard deviation. p values less than 0.05 were considered significant (see Table 1).

Results

Five hundred and sixty-four Caucasian eyes were evaluated. The subject's ages range from 6 to 85 years (mean, 42 ± 17.1 years). The study group consisted of 144 males and 137 females. The MCD of the population was 2732 ± 305 cell/mm² (range, 1904–3802 cell/mm²). The MCA was 368 ± 41 m² (range, 263–522 m²). The mean CV in cell size was 34 ± 7 (range, 25–68), the mean percentage of hexagonal cells was 46 ± 8% (range, 25–76%), and CCT was 513 ± 39 (range, 407–623). Patients were divided into groups on the basis of age. For those groups, age was subdivided into decades, resulting in 7 subgroups as shown in Table 2.

There was statistically significantly negative correlation (p < 0.05) between age and cell density, hexagonality, and pachymetry. There was statistically significant correlation (p < 0.05) between age and MCA (Table 3). The corneal endothelial cell characteristics had no significant difference (p > 0.05) between males and females (Table 4).

Discussion

The corneal endothelial cells have no regenerative capacity. Thus, reduction in corneal endothelial cell density

Table 1. Endothelial cell characteristics of the study population.

| Characteristic | Min–Max | Mean ± SD | Median |
|---------------|---------|-----------|--------|
| Cell density  | 1904–3802 | 2752 ± 305 | 2732 |
| CV in cell size | 25–68 | 44 ± 7 | 43 |
| Hexagonality  | 25–76 | 46 ± 8 | 46 |
| Cell area     | 263–522 | 368 ± 41 | 366 |
| Pac           | 407–623 | 513 ± 39 | 510 |

Table 2. Endothelial cell characteristics of the study population in different age groups.

| Age | Cell density | CV in cell size | Hexagonality | Cell area | Pac |
|-----|--------------|-----------------|--------------|-----------|-----|
|     | Med | Mean ± SD | Med | Mean ± SD | Med | Mean ± SD | Med | Mean ± SD |
| 6–20 | 3120 | 3101 ± 268 | 41 | 43 ± 9 | 55 | 52 ± 10 | 321 | 329 ± 28 |
| 20–29 | 2805 | 2843 ± 285 | 45 | 46 ± 7 | 47 | 46 ± 8 | 357 | 355 ± 34 |
| 30–39 | 2809 | 2798 ± 247 | 42 | 44 ± 7 | 46 | 46 ± 7 | 356 | 360 ± 31 |
| 40–49 | 2695 | 2714 ± 263 | 43 | 44 ± 6 | 43 | 44 ± 6 | 371 | 373 ± 37 |
| 50–59 | 2657 | 2632 ± 277 | 42 | 43 ± 7 | 47 | 47 ± 8 | 374 | 384 ± 43 |
| 60–69 | 2545 | 2558 ± 233 | 45 | 45 ± 8 | 45 | 45 ± 8 | 393 | 393 ± 37 |
| >70  | 2595 | 2571 ± 283 | 43 | 45 ± 9 | 46 | 45 ± 8 | 394 | 394 ± 44 |

Table 3. Correlation analyzed results between age.

| Characteristic | Correlation Coefficient |
|----------------|-------------------------|
| Cell density   | r = -0.461, p = 0.005   |
| CV in cell size| r = -0.134, p = 0.002   |
| Hexagonality   | r = -0.128, p = 0.002   |
| Cell area      | r = 0.134, p = 0.458    |
| Pac            | r = -0.128, p = 0.002   |

Spearman correlation.
is compensated by way of cell spreading which ends up with increased cellular pleomorphism and a decrease in the percentage of hexagonal cells.\textsuperscript{15} In many studies it was shown that corneal endothelial cell density changes in different ethnic origins and with aging.\textsuperscript{7-11} These studies report that MCD, percentage of hexagonal cells, and pachymetry decrease with age. On the other hand MCA increases with age.

Hashemian et al. reported a mean endothelial cell density of 1961 ± 457 cell/mm\textsuperscript{2} among 525 eyes of normal Iranian people aged 20 – 85 years old with a noncontact specular microscopy (SP2000: Topcon corporation, Japan).\textsuperscript{12} In a study, mean endothelial cell density of 537 normal Indian volunteers aged 20 – 87 years was founded 2525 ± 337 cell/mm\textsuperscript{2}.\textsuperscript{8} Yunliang et al. performed specular microscopy in 1329 eyes of 700 healthy Chinese people aged 10 – 98 years and evaluated the mean endothelial cell density of their population as 2932 ± 363 cell/mm\textsuperscript{2} with (Noncon Robo SP-9000; Konan, Hyogo, Japan).\textsuperscript{13} Ceyhun et al. reported a mean endothelial cell density of 2671 ± 356 among 252 eyes of normal Turkish people aged 20 – 70 with noncontact specular microscopy (SP-3000P: Topcon corporation, Tokyo, Japan).\textsuperscript{14}

In our study, Caucasians' cell density is more than the Indian and Iranian, and less than the Chinese patients.

There are insufficient data regarding corneal endothelial cell parameters involving patients under the age of 20 years among many populations. Liang et al. performed specular microscopy in 133 adolescent students of Maonan nationality and 105 adolescent students of Han nationality in China whose ages ranged from 5 to 20 years. In this study cell densities were 2969.50 ± 253.93 and 2998.26 ± 262.65 cell/mm\textsuperscript{2} respectively.\textsuperscript{15} Farhan et al. evaluated corneal endothelial cell in 412 healthy Saudi children aged 7–12 years and mean cell density was found to be 3176 ± 208.\textsuperscript{16} In our study, cell density in under the age of 20 among Caucasian population was 3101 ± 268 cell/mm\textsuperscript{2}. This view is a higher number than the Chinese population. These differences should be evaluated by regarding corneal surface area.

The corneal endothelial cell density measurements can also be affected by corneal surface area as well as specular microscopy type and model of the instrument. The cell density measurements, when the corneal surface area is also factored in, can provide more accurate results.\textsuperscript{17} In this study we did not measure corneal surface area.

Contact and noncontact specular microscopy can be used for measurement and Topcon SP 3000 was used in many studies as noncontact specular microscopy. In our study, we used Konan SP 9900 as a noncontact specular microscopy. There are several kinds of instruments that can be used to analyze endothelial cell characteristics. It is important to be aware of the technique used and the type of instrument used to compare measurements of endothelial cell parameters of the patients. Several studies have compared endothelial cell counts from varied instruments to find out whether they can be used interchangeably or not.\textsuperscript{18,19} Gasser et al. compared two noncontact specular microscopes, Topcon SP3000P and Konan Noncon Robo SP8000. In this analysis, the endothelial cell densities measured by the Konan were systematically higher than the values measured by the Topcon.\textsuperscript{20} In a study by De Sanctis et al., Topcon SP2000P was compared with Konan CC7000 noncontact specular microscope. This study revealed that endothelial cell densities measured with the Konan were significantly higher than the measurements performed with the Topcon.\textsuperscript{17} Contact specular microscope gives more reliable results than noncontact type.\textsuperscript{16} Directly touching the cornea is the main disadvantage of contact specular microscopy.

In our study, as mentioned in other studies, central corneal thickness was found to decrease with age.\textsuperscript{3,7-9}

In our study we describe the normative endothelial data in a Caucasian population. Over the age of 20, the MCD of Caucasian eyes is more than the Indian and Iranian eyes and less than the Chinese eyes.

**Conflict of interest**

The authors declared that there is no conflict of interest.

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