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Original article

Corneal endothelial cell density in healthy Caucasian population

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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/mm^2 (range, 1904–3802 cell/mm^2). The MCA was 368 ± 41 m^2 (range, 263–522 m^2). 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). 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/mm^2.

Keywords: Corneal endothelium, Cell density, Specular microscopy

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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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the study in Bursa Yüksek İhtisas Training and Research Hospital between January 2015 and May 2015. The study was approved by the hospital's Review Board and Ethics Committee, and all participants signed an informed consent. The study was planned and conducted in accordance with the Helsinki Declaration.

Routine ophthalmological examination was performed before specular microscopy. Exclusion criteria were history of ocular disease (corneal scar, cataract, glaucoma, keratoconus and retinal disease), evidence of endothelial dystrophy on slit-lamp biomicroscopy, contact lens wear, dry eye disease, systemic treatment, and any history of previous ocular surgery. Endothelial cell density (MCD), mean cell area (MCA), coefficient of variation (CV) in cell size, percentage of hexagonal cells, and central corneal thickness (CCT) of all patients were obtained with NSP 9900 noncontact specular microscopy (Konan Medical Inc., Hyogo, Japan) device. All measurements were taken by two doctors (DR SGÇ, DR RD) between 9:00 and 11.00 am. Measurements were performed three times in the center of the cornea and at least 100 contiguous cells were analyzed by computer. After that the average value of the three measurements was taken.

The Konan NSP 9900 noncontact specular microscopy is a noncontact specular microscope with an autofocus device. The image of the endothelium is obtained on an incorporated screen. After a clear image of the central endothelium was captured, the computer performed an automated analysis of the cell parameters that were displayed on the screen and then a printout was obtained.

The CV in cell size (standard deviation divided by the mean cell area) was used as an index of the extent of variation in the cell area (polymegathism). The percentage of hexagonal cells in the analyzed area was used as an index of variation in cell shape (polymorphism). It has become easier to try to assess this variability by reporting on the polymegethism (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).

Table 1. Endothelial cell characteristics of the study population.

	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

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/mm^2 (range, 1904 –3802 cell/mm^2). The MCA was 368 ± 41 m^2 (range, 263 –522 m^2). 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 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	Med	Mean ± SD
6–20	3120	3101 ± 268	41	43 ± 9	55	52 ± 10	321	325 ± 28	535	527 ± 51
20–29	2805	2843 ± 285	45	46 ± 7	47	46 ± 8	357	355 ± 34	512	516 ± 42
30–39	2809	2798 ± 247	42	44 ± 7	46	46 ± 7	356	360 ± 31	507	513 ± 37
40–49	2695	2714 ± 263	43	44 ± 6	43	44 ± 6	371	373 ± 37	512	515 ± 35
50–59	2657	2632 ± 277	42	43 ± 7	47	47 ± 8	374	384 ± 43	507	511 ± 34
60–69	2545	2558 ± 233	45	45 ± 8	45	45 ± 8	393	393 ± 37	504	509 ± 30
>70	2595	2571 ± 283	43	45 ± 9	46	45 ± 8	394	394 ± 44	484	486 ± 38

Table 3. Correlation analyzed results between age.

	Cell density	CV in cell size	Hexagonality	Cell area	Pac
Age					
r	−0.461	0.005	−0.134	0.458	−0.128
p	0.000	0.911	0.002	0.000	0.002

Spearman correlation.

Table 4. Endothelial cell characteristics in female and male.

	Female		Male		*p*
	Mean ± SD	Median	MEAN ± SD	Median	
Cell density	2749 ± 307	2710	2754 ± 303	2755	0.383
Cv in cell size	45 ± 8	44	43 ± 7	42	0.06
Hexagonality	45 ± 8	44	47 ± 7	47	0.12
Cell area	368 ± 41	368	368 ± 42	363	0.470
Pac	513 ± 35	510	513 ± 43	510	0.998

Mann–Whitney U test.

is compensated by way of cell spreading which ends up with increased cellular pleomorphism and a decrease in the percentage of hexagonal cells.[3] In many studies it was shown that corneal endothelial cell density changes in different ethnic origins and with aging.[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^2 among 525 eyes of normal Iranian people aged 20 –85 years old with a noncontact specular microscopy (SP2000: Topcon corporation, Japan).[12] In a study, mean endothelial cell density of 537 normal Indian volunteers aged 20 –87 years was founded 2525 ± 337 cell/mm^2.[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^2 with (Noncon Robo SP-9000; Konan, Hyogo, Japan).[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).[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^2 respectively.[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.[16] In our study, cell density in under the age of 20 among Caucasian population was 3101 ± 268 cell/mm^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.[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.[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.[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.[17] Contact specular microscope gives more reliable results than noncontact type.[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.[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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