

# There are no differences in corneal endothelial cell density between emmetropic, myopic and hyperopic subjects

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## SUMMARY

The objective of this study was to analyze the differences in corneal endothelial cell density between emmetropic, myopic and hyperopic subjects. Corneal endothelial cell density (cells/mm<sup>2</sup>) was analyzed in 30 emmetropic (n=30; 27.3±4.0 years old), 30 myopic (n=30; 26.6±4.1 years old) and 30 hyperopic (n=30; 26.8±4.4 years old) subjects. The mean of three consecutive measurements of corneal endothelial cell density was obtained by means of non-contact specular microscopy (Topcon SP-2000P noncontact specular microscope, Topcon Corp., Tokyo, Japan).

Corneal endothelial cell density ranged from 2833 to 3300 cells/mm<sup>2</sup> (mean±SD, 3076±123 cells/mm<sup>2</sup>), from 2825 to 3316 cells/mm<sup>2</sup> (mean±SD, 3048±152 cells/mm<sup>2</sup>), and from 2820 to 3262 cells/mm<sup>2</sup> (mean±SD, 3033±115 cells/mm<sup>2</sup>) in emmetropic, myopic and hyperopic eyes respectively. No significant differences between emmetropic, myopic and hyperopic eyes were found (p=0.404).

In sum, there is no difference in corneal endothelial cell density between emmetropic, myopic and hyperopic eyes.

**Key words:** Cornea – Endothelial cell density – Noncontact specular microscopy – Refraction

## INTRODUCTION

The human corneal endothelium is a non-regenerative cell layer that loses cells at a very slow rate throughout life, while normally retaining sufficient cells for corneal clarity (Bourne and McLaren, 2004).

Specular microscopy is a useful tool for analyzing corneal endothelial cell density (ECD) in vivo. Several specular microscopy studies have focused on ECD values (Pérez-Santonja et al., 1997; Erickson et al., 1998; Lee et al., 2001; Snelligen et al., 2001; Modis et al., 2002; Sanchis-Gimeno et al., 2003; Bourne and McLaren, 2004; Padilla et al., 2004).

Nevertheless, currently there is a lack of information on ECD values in relation to refractive status, particularly because ECD studies are not usually performed on emmetropic eyes.

We therefore, decided to ascertain if there were differences in ECD values between emmetropic, myopic and hyperopic subjects.

## MATERIALS AND METHODS

We carried out a prospective study involving 90 eyes of 90 volunteers. Participation was voluntary and informed consent was obtained after provision of information about the nature of the study had been given.

Subjects with prior corneal and/or ocular surgery, corneal disease, clinical corneal changes, Goldmann applanation tonometry  $\geq 21$  mm Hg,

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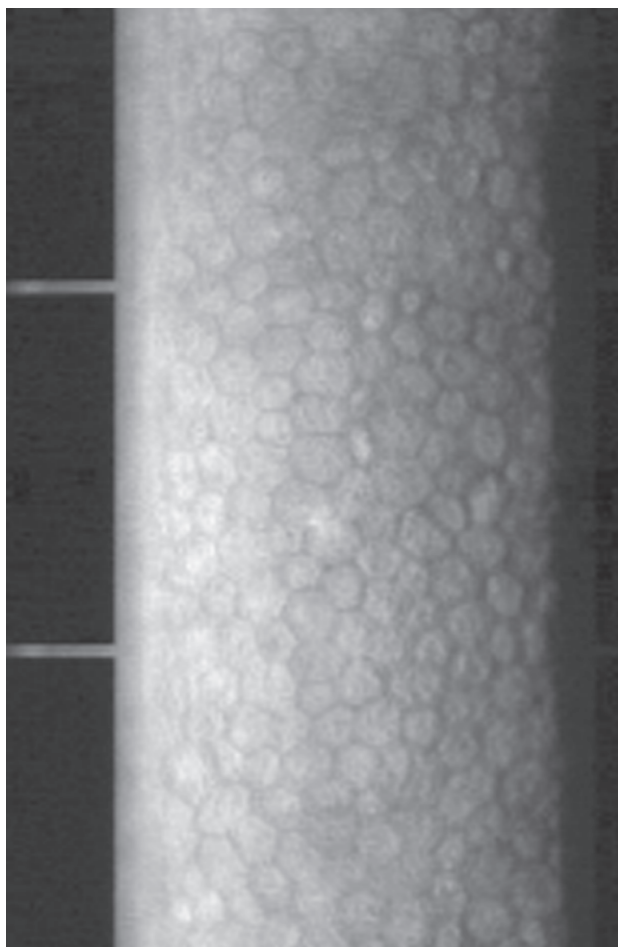
and/or systemic disease were excluded. Subjects taking any kind of medication were also excluded.

The volunteers were subdivided into three groups: the emmetropic group (spherical equivalent refraction ranging from -0.5 to +0.5 diopters), the myopic group (spherical equivalent refraction > -0.5 diopters), and the hyperopic group (spherical equivalent refraction > +0.5 diopters). The subjects' characteristics are shown in Table 1.

**Table 1.-** Characteristics of the subjects studied.

|                    | Emmetropic group | Myopic group | Hyperopic group |
|--------------------|------------------|--------------|-----------------|
| n                  | 30 (100%)        | 30 (100%)    | 30 (100%)       |
| Age *              | 27.3±4.0         | 26.6±4.1     | 26.8±4.4        |
| SER (diopters) * † | 0.33±0.05        | -2.15±1.0    | +1.9±0.6        |
| BCVA ≥ 20/20 ‡     | 30 (100%)        | 20 (66.6%)   | 30 (100%)       |
| Tonometry (mmHg) * | 15.9±1.1         | 15.4±1.8     | 15.6±1.9        |

\* = mean±SD  
 † SER = Spherical equivalent refraction  
 ‡ BCVA = Best corrected visual acuity



**Fig. 1.-** Noncontact specular photograph of the corneal endothelial cells of a young myopic woman. x 132.

The ECD was recorded from 10 a.m. to 11 a.m. by one physician using the Topcon SP-2000P noncontact specular microscope (Topcon Corp., Tokyo, Japan). Photographs of the center of the cornea were taken using automatic-mode low flash intensity (Figure 1). The endothelial cell count was performed using built-in image analysis software. On each image, 25 cells were counted manually. Then, the images were printed with the data analyzed (Modis et al., 2002). The estimated ECD density (number of cells per mm<sup>2</sup>) was the mean of the three consecutive measurements (Sanchis-Gimeno et al., 2003).

Only the left eye was contemplated for the statistical analysis. The choice of limiting the study to the left eye instead of the right eye was random. The Kolmogorov-Smirnov test, Student's t-test and a 1-way ANOVA test were applied. P values less than 0.05 were considered to be statistically significant.

## RESULTS

Significant differences in spherical equivalent refraction between emmetropic, myopic and hyperopic subjects were found (p<0.001; 1-way ANOVA test). No significant differences in age (p=0.793; 1-way ANOVA test) or tonometry (p=0.475; 1-way ANOVA test) between emmetropic, myopic and hyperopic eyes were found. The differences in age (p=0.548; Student's t-test), tonometry (p=0.874; Student's t-test) and spherical equivalent refraction (p=0.171; Student's t-test) between emmetropic women and men were not significant. The differences in age (p=0.460; Student's t-test), tonometry (p=0.365; Student's t-test) and spherical equivalent refraction (p=0.490; Student's t-test) between myopic women and men were not significant. Neither were the differences in age (p=0.330; Student's t-test), tonometry (p=0.269; Student's t-test) and spherical equivalent refraction (p=0.703; Student's t-test) between hyperopic women and men.

Table 2 shows the ECD values obtained from emmetropic, myopic and hyperopic eyes. No significant differences in ECD between emmetropic, myopic and hyperopic eyes were found (p=0.404; 1-way ANOVA test). No significant differences in ECD values between the men and

**Table 2.-** Corneal endothelial cell density of the subjects analyzed (cells/mm<sup>2</sup>).

|         | Emmetropic eyes |       |      | Myopic eyes |       |      | Hyperopic eyes |       |      |
|---------|-----------------|-------|------|-------------|-------|------|----------------|-------|------|
|         | All             | Women | Men  | All         | Women | Men  | All            | Women | Men  |
| n       | 30              | 15    | 15   | 30          | 15    | 15   | 30             | 14    | 16   |
| Mean    | 3076            | 3111  | 3042 | 3048        | 3064  | 3033 | 3033           | 3028  | 3038 |
| SD      | 123             | 562   | 106  | 152         | 564   | 680  | 115            | 550   | 105  |
| Minimum | 2833            | 2885  | 2833 | 2825        | 2827  | 2825 | 2820           | 2824  | 2820 |
| Maximum | 3300            | 3300  | 3265 | 3316        | 3316  | 3278 | 3262           | 3262  | 3208 |

women were found in emmetropic ( $p=0.116$ ; Student's t test), myopic ( $p=0.173$ ; Student's t test), and hyperopic subjects ( $p=0.813$ ; Student's t test).

## DISCUSSION

We used specular microscopy in order to obtain the ECD values in vivo. A specular microscope is an optical system that relies on the reflected light from an incident beam projected onto the corneal surface and shows the cellular shape and configuration at a magnification determined by the optics of the system. Focusing on the endothelium, the specular microscope provides specular images and a reflection of light from the epithelial and endothelial surfaces (Modis et al., 2002). From these specular images one can examine the corneal endothelial cells and calculate the ECD (Bourne and McLaren, 2004).

We analyzed the ECD of emmetropic, myopic and hyperopic subjects. Emmetropic eyes can be considered "normal anatomic eyes", and it seems that emmetropia is more prevalent than myopia and hyperopia (Montes-Mico and Ferrer-Blasco, 2000) although ECD studies are not usually performed on these eyes.

Our myopic and hyperopic subjects were pre-LASIK patients recruited from our refractive surgery unit. In a study involving LASIK patients, Pérez Santonja et al. (1997) obtained ECD values of  $2997 \pm 314$  cells/mm<sup>2</sup> very similar to those obtained by us. In the three groups of subjects analyzed there were no significant differences between women and men in age, tonometry or spherical equivalent refraction. Moreover, there were no differences in age and tonometry between emmetropic, myopic and hyperopic subjects.

We did not obtain significant differences in ECD between emmetropic, myopic and hyperopic subjects. Moreover, the results of our myopic and hyperopic subjects were not affected by the use of contact lenses (Sanchis-Gimeno et al., 2003). Thus, the ECD values of myopic and hyperopic noncontact lens wearers are similar to the values of the emmetropic subjects.

We did not find differences between women and men in ECD. However, we only analyzed a small sample of subjects, and studies carried out on larger samples have afforded results that differ from those presented in this study (Snelligen

et al., 2001; Padilla et al., 2004). A recent study found that females had an ECD that was 7.8% higher than that of males, suggesting the possibility of a higher corneal endothelial reserve in females (Padilla et al., 2004).

In sum, we analyzed emmetropic, myopic and hyperopic Caucasian subjects by means of non-contact specular microscopy and we detected no significant differences in ECD between them.

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