·Clinical Research·

Corneal endothelial cell density and morphology in low and moderate myopic Chinese eyes

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Abstract

• **AIM: To describe and compare the corneal endothelial cell density and morphology in young, low and moderate myopic Chinese adults in Malaysian Chinese population.**

• **METHODS: Non-contact specular microscopy (Topcon SP3000P, Tokyo, Japan) was performed in low (*n*=78; 21.22±1.51 years) and moderate (*n*=78; 21.82±1.40 years) myopic subjects. The mean of three consecutive measurements of endothelial cell density (MCD), coefficient of variation (CV) in the cell size, and hexagonal appearance of the cell were obtained.**

• **RESULTS: In low myopic eyes the MCD was 3 063.0±176.2/mm^2, the mean CV was 33.4±4.0% and the mean hexagonal appearance of the cell was 57.9±2.7%. In moderate myopic eyes the MCD was 2961.6±159.0/mm^2, the mean CV was 33.9±3.6% and mean hexagonal appearance of the cell was 56.2±4.7%. There were statistically significant differences in MCD (P<0.000) and hexagonal appearance of the cell (P<0.005) between low and moderate myopic eyes.**

• **CONCLUSION: The corneal endothelial cell layer in more myopic eyes tends to have less MCD and cell hexagonality compared to lower myopic eyes. Nevertheless, there is no significant difference in CV between low and moderate myopic eyes.**

• **KEYWORDS:** cornea; myopic eyes; specular microscopy; endothelial cell density; morphology

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INTRODUCTION

The human corneal endothelial cell is a non-regenerating predominantly hexagonal cell which covers the posterior surface of decrement's membrane and faces the anterior chamber of the eye. Corneal endothelium is metabolically active and plays an imperative role in maintaining the corneal transparency by pumping water from stroma to the aqueous humor and keeping the stroma in the dehydrated level of 70% of water.

Corneal endothelial cell density and morphology can be analyzed using specular microscope. The specular microscope has been shown to be reliable and reproducible with appropriate calibration of the instrument[1-3].

Non-contact Specular microscope provides a non-invasive method of morphological analysis of the corneal endothelial cell layer. It makes the measurement of mean cell density (MCD), measurement of coefficient of variation (CV) in the cell size as well as hexagonal appearance of the cell. These parameters provide an index of the functional status of corneal endothelial layer[4].

Myopia is a common pathologic change of the eye, especially in Asian countries undergoing rapid development [5,6]. It is known that Asian people have a higher prevalence of myopia[5-7]. High levels of myopia are associated with increased risk of cataract, posterior vitreous detachment, retinal tears and retinal detachment, increased risk of choroidal neovascularization, and myopic macular degeneration [8-12]. In spite of an impressive body of research, little is known about the effect of myopia on the cornea, particularly the corneal endothelium. Although few studies have shown a relationship between corneal endothelial cell characteristics and myopia[4,13,14], there is still a lack of information on corneal endothelial cell parameters in relation to degree of myopia.

Further, corneal endothelial cell density and morphology in young low and moderate myopic eyes has never been documented. Therefore, this study aims to describe the corneal endothelial cell density and morphology in young, low and moderate myopic Chinese adults and to compare the corneal endothelial characteristics with respect to degree of myopia.

SUBJECTS AND METHODS

Subjects A prospective study was carried out from January

2012 to May 2012 and a total of 156 eyes (only right eye) from 156 subjects, aged 18-24 years old were recruited. None of them had previous contact lens wear, ocular, systemic disease or/and surgery history. Informed consents were obtained from all subjects before being enrolled in this study and the Declaration of Helsinki was followed throughout the study. Followed by a comprehensive ocular examination, thorough examinations were carried out to exclude cases with best corrected visual acuity of worse than 20/20 in each eye, ocular pathology except myopia and myopia associated chorioretinal changes. For the purpose of comparison between different degrees of myopia, cycloplegic refraction was measured with an autorefractor (Topcon RK-3000). Based on the results, determination of "low" and "moderate" myopia was made, retrospectively. Those with astigmatism more than -1DC and/or myopia more than -6.00DS were excluded. In low myopic subjects, the spherical equivalent refraction ranged between ⩾-0.25DS to <-3.00DS and ⩾-3.00DS to <-6.00D in moderate myopic group,respectively.

Methods A non-contact specular microscope (Topcon SP3000P, Tokyo, Japan) was used to assess the central corneal endothelium and each measurement was taken between 10:00 and 11:00 a.m. by a single examiner. The procedure for specular microscopy was as follows: three images from the central cornea were captured of at least 80 contiguous cells and were manually marked with a mouse by the examiner for analysis by a built-in software program.

The computer automatically evaluated, calculated and displayed the mean cell density (cell/mm^2), CV in cell size and percentage of hexagonal cells. The mean of each variable from the three best images of central cornea was used for MCD, CV and hexagonality of cells.

Statistical Analysis Data were analyzed using SPSS statistical program (version 19.0). Mean differences, standard deviation and correlation between observations were calculated. Normality of data was checked using Shapiro-Wilk test. Mean of different variables between low and moderate myopia were tested by independent Student's t-test. A probability of 0.05 was considered statistically significant.

RESULTS

Characteristics of corneal endothelial cells were studied in 156 eyes of young myopic Chinese adults with the mean age of 21.5±1.45 years and an average refractive error of -2.87±0.81D. Among the participants, 85 were male and 71 were female.

Low myopic subjects had the mean age of 21.22±1.50 (range, 18-24) years and the mean spherical equivalent of refraction error of -1.51±0.84D (range, -0.50 to -2.75). In moderate myopic subjects, the mean age was found to be 21.82±1.40 (range, 18-24) and the mean spherical equivalent of refraction error was -4.25±0.78D (range, -3.25 to -6.00). Table 1 presented the specular microscopy findings of corneal endothelial cell parameters including MCD, CV in cell size and hexagonal appearance of the cells (HC) in low and moderate myopic population.

Table 1 Corneal endothelial characteristics in low and moderate myopic subjects

Parameters	Mean±SD	Range
Low myopia (n=78 eyes)		
MCD (cell/mm²)	3063.0±176.2	2430-3529
CV (%)	33.4±4.0	27-35
HC (%)	57.9±2.7	52-63
Moderate myopia (n=78 eyes)		
MCD (cell/mm²)	2961.6±159.0	2196-3320
CV (%)	33.9±3.6	26-37
HC (%)	56.2±4.7	53-60

MCD: mean cell density; CV: coefficient of Variation; HC: hexagonal appearance of cell.

Table 2 Comparison of corneal endothelial parameters between low and moderate myopic groups

Parameters	P
MCD	0.001
CV	0.546
HC	0.005

Comparing corneal endothelial cell parameters among different levels of myopia, the MCD and the mean percentage of hexagonal appearance of cell were significantly different (P<0.05). In moderate myopic subjects, the MCD and the mean percentage of hexagonal appearance of the cell were lower than low myopic subjects. However, the difference in CV in the cell size was statistically insignificant (P>0.05). Table 2 displays the results of comparison of corneal endothelial parameters between low and moderate myopic groups.

The correlation between corneal endothelial cell parameters was assessed, using Pearson Correlation. Based on the results, as the MCD decrease the percentage of hexagonal appearance of the cell decrease and the percentage of CV in the cell size increase. Moreover, there was a correlation between the percentage of hexagonal appearance of the cell and the percentage of CV in the cell size.

Corneal endothelial cell layer with higher percentage of hexagonal appearance of the cell tends to have less CV in the cell size. Table 3 sums up the correlation between corneal endothelial parameters.

DISCUSSION

The function of corneal endothelium in modifiability of stromal hydration level and preserving the corneal transparency is well understood. This function is executed by active metabolic pumps in the corneal endothelium which persistently removes the fluid out of the corneal stroma [4].

Table 3 Summary of correlation between corneal endothelial parameters

Parameters	HC	CV
MCD	*r*=0.68	*r*=-0.21
	P=0.004	*P*=0.038
CV	*r*=-0.22	*r*=1.00
	P=0.024	
HC	*r*=1.00	*r*=-0.22
		P=0.024

r: Pearson's correlation coefficient.

Damage to corneal endothelial cells caused by intraocular surgery, glaucoma, trauma or diseases, including Fuchs' corneal dystrophy, may result in irreversible corneal edema, since there is little or no mitotic activity in the human corneal endothelial cells after birth[15,16].

Assessment of corneal endothelial cell density and morphology provides important information on corneal endothelial function and viability and become an acceptance factor in practice and research to provide valuable information on this layer[4,17].

Corneal endothelial morphology can be measured with various instruments such as contact specular microscope, non contact specular microscope and confocal biomicroscope. Non contact specular microscopy is found to be more patients friendly and less hazardous for any corneal epithelial damage and infection transmission[4,17]. As a result, it has been widely used in studies of corneal endothelial cell density and morphology[14].

Few studies have been discussed on the relationship between corneal endothelial cell density and morphology and refractive error. Despite various results; the significant changes in corneal endothelial characteristics do exist. Various types of refraction error have various corneal endothelial characteristics[4,13,14,18].

Decisions regarding corneal endothelial cell changes in individual with different type or degree of refractive error should be based on normative data derived from the underlying population. This study provides data on endothelial cell characteristics in a sample of low and moderate myopic Chinese eyes in Malaysian population.

The results of this study have shown that corneal endothelial layer in moderate myopic eyes tends to have less density and hexagonal appearance of the cell compare to low myopic eyes. There are conflicting reports regarding the effects of refractive error on corneal endothelial characteristics. Although few studies have concluded that there are no significant changes in corneal endothelial parameters between different types or degree of refractive error, others have stated adversely[4,13,14,19]. The progression of myopia leads to elongation of the eye ball[19]. As a result, the more myopic eye tends to have more enlargement of the globe. It has been suggested that as long as the eye elongate, the corneal endothelial surface area increases [13]. Due to little or no mitotic activity of the corneal endothelial cells after birth, it is likely that the corneal endothelial cells have to floor the enlarged surface [13,15,16,20]. Then, reduced corneal endothelial density is expected. Since corneal endothelial cells have to flatten to conquer the enlarged surface, it is conceivable that the possibility of polymorphism increases [13]. Subsequently, the percentage of hexagonal appearance of the cells decreases.

In conclusion, this study proposes that, the changes in the density of the corneal endothelial cells and the percentage of hexagonal appearance of the cells are subjective to the degree of myopia. It would be likely that low myopic eyes have lower MCD and percentage of hexagonal appearance of the cells than moderate myopic eyes. Future researches should focus on the effects of high myopic refractive error on corneal endothelial cell layer.

Although the effects of aging and ethnicity on corneal endothelial cell characteristics are clear, detailed modeling studies are needed, investigating the results of myopia within different age groups and populations in order to have a better understanding of corneal endothelial cells changes [21,22]. Besides, in the absence of longitudinal data on the corneal endothelial cell changes preceding myopia onset, further studies are required to determine the cause-effect relationship between corneal endothelial cell changes and myopia onset.

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