ORIGINAL ARTICLE

Corneal endothelial cell density and morphology in normal Malay Eyes

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SUMMARY

This study was conducted to describe corneal endothelial cell density and morphology in Malay eyes. Non-contact specular microscopy was performed in 125 eyes of 125 Malay volunteers, aged 20-87 years. Studied parameters included endothelial cell density (CD), mean cell area (MCA), coefficient of variation (CV) in cell area, as well as hexagonal appearance of the cells. Mean endothelial cell density in the study population was 2648 ± 310 cell/mm². Mean CA, CV and percentage of hexagonal cells were 382.8 ± 47.7µm², 58.1 ± 22.6, 44.3% ± 11.5% respectively. There was a statistically significant decrease in endothelial cell density (correlation - 0.300, P = 0.001) and CV in cell size (correlation - 0.208, P = 0.02) with age. There was a statistically significant increase in mean cell area (correlation 0.300, P = 0.001) with increasing age. The correlation between age and percentage of hexagonal cells was insignificant (correlation 0.074, P = 0.41). In conclusion, a consistent decrease was noted in the endothelial cell density with increasing age. The differences in endothelial cell density between genders were statistically insignificant.

KEY WORDS:
Malay Eyes, Specular Microscopy, Corneal Endothelium, Morphology

INTRODUCTION

The corneal endothelium consists of a single layer of non-regenerating predominantly hexagonal cells. It plays a vital role in maintaining a crystal clear cornea by securing a state of relative dehydration of the corneal stroma. At birth the endothelial cell count ranges between 4000 cells/mm^2 and 5000 cells/mm^2. With aging the cell count will decline to approximately 2000 to 3000 cells/mm2 in a normal adult eye. A cornea with an endothelial cell count of 500 cells/mm2 or less is at risk of decompensation, which may eventually result in corneal oedema [1].

Factors which contribute to a decrease in endothelial cells density include age, trauma, intraocular surgery and certain corneal diseases [2,3].

The specular microscope enables one to examine the corneal endothelium in detail using a magnification hundred times greater than the slit lamp biomicroscopy. Its ability to produce clear images of corneal endothelial cells has enabled ophthalmologists to study the characteristics of corneal endothelial cells in normal and diseased eyes.

MATERIALS AND METHODS

A total of 125 eyes from 125 volunteers aged 20-87 years were studied (mean age 45.8 ± 20.7 years). Eyes of volunteers with a history of trauma, intraocular surgery, uveitis, glaucoma, diabetes mellitus, high intraocular pressure, corneal opacity and evidence of corneal endothelial dystrophy on slit-lamp biomicroscopy were excluded from the study. Cataract was evident in the older age group. Informed consent was obtained from all the participants followed by a comprehensive ocular examination.

For the purpose of comparison between different age groups, we categorized the subjects by age into 6 subgroups, namely 20 to 30 years, 31 to 40 years, 41 to 50 years, 51 to 60 years, 61 to 70 years and more than 70 years.

A non-contact specular microscope (Topcon SP3000P, Tokyo, Japan) was used to examine the central corneal endothelium and obtain the following parameters: mean cell density (cells/mm^2), mean cell area (mm^2), coefficient of variation (CV) in cell area, and percentage of hexagonal cells.

The specular microscope incorporates an auto alignment and auto capture system that ensures ease of operation and reliable results. In addition, it is a noninvasive, safe and relatively affordable tool.

The procedure was performed by projecting light onto the cornea and imaging the reflected light from an optical interface of the corneal tissue, most typically the endothelium - aqueous interface. When the light beam passes through the cornea, it encounters a series of interfaces between optically distinct regions. Some light reflects back specularly toward the photomicroscope when the angle of reflection is same as the angle of incidence. The specular light is captured by the photomicroscope to form an image which can be photographed and analyzed. Endothelial cell density (endothelial cell count/mm^2) is the most familiar parameter studied. An additional feature built into modern specular microscopes is software algorithms which determine the percentage of cells that show polymegthism (variation in cell size) and pleomorphism (variation in cells shape) [1].

The less healthy the endothelium may have the lower endothelial cell count and the greater variation in cell size and cell shape (hexagonal cells) [1].

Three images from the central cornea were captured and the best image was then selected. The centers of at least 100

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Table I: Characteristics of the endothelial cells in different age groups of the study population

Age group (years)	Age (Mean±SD)	Number of eyes	Cell density (cell/mm²) (Mean±SD)	Cell area (µm²) (Mean±SD)	CV in cell size (%) (Mean±SD)	Hexagonality (%) (Mean±SD)
20-30	23.7±1.9	49	2783±286	363±38.15	63.5±23.2	43.8±12.8
31-40	35.4±2.8	9	2551±319	397.5±51.3	69.2±29.5	39.6±10.9
41-50	45.0±3.0	10	2744±239	366.9±32.9	47.0±9.75	48.9±8.23
51-60	56.0±2.3	15	2509±228	401.6±36.6	55.2±27.0	46.6±8.55
61-70	66.5±2.6	25	2560±304	395.7±45.8	54.8±23.7	46.0±12.3
>70	75.7±4.9	17	2570±301	393.9±44.9	51.3±20.5	44.0±10.3

Table II: Endothelial cell density in male and female

Age group (years)	Male cell density (cell/mm²) (Mean±SD)	Female cell density (cell/mm²) (Mean±SD)	P value
20-30	2742±217	2776±325	0.649
31-40	2728±319	2536±285	0.198
41-50	2668±246	2783±197	0.409
51-60	2657±172	2488±312	0.063
61-70	2454±250	2538±340	0.347
>70	2524±186	2612±381	0.410

Table IV: Comparison of Endothelial Cell Density in Malay, American, Indian, Japanese Filipino and Thai Populations

	Malay		American [4]		Japanese [4]		Indian [5]		Filipino [7]		Thai [8]		Chinese [6]	
Age group (years)	No. of eyes	Cell density (cell/mm²) (Mean±SD)	No. of eyes	Cell density (cell/mm²) (Mean±SD)	No. of eyes	Cell density (cell/mm²) (Mean±SD)	No. of eyes	Cell density (cell/mm²) (Mean±SD)	No. of eyes	Cell density (cell/mm²) (Mean±SD)	No. of eyes	Cell density (cell/mm²) (Mean±SD)	No. of eyes	Cell density (cell/mm²) (Mean±SD)
20-30	49	2783±286	11	2977±324	18	3893±259	104	2782±250	114	2949±270	94	2799 ± 260	100	2988 6 243
31-40	9	2551±319	6	2739±208	10	3688±245	96	2634±288	112	2946±296	50	2744 ± 236	100	2920 6 325
41-50	10	2744±239	11	2619±321	10	3749±407	97	2408±274	112	2761±333	104	2642 ± 304	97	2935 6 285
51-60	15	2509±228	13	2625±172	10	3386±455	98	2438±309	102	2555±178	78	2553 ± 266	97	2810 6 321
61-70	25	2560±304	8	2684±384	6	3307±330	88	2431±357	114	2731±299	50	2485 ± 267	90	2739 6 316
>70	17	2570±301	15	2431±339	5	3289±313	54	2360±357	86	2846±467	28	2189 ± 416	83	2778 6 365

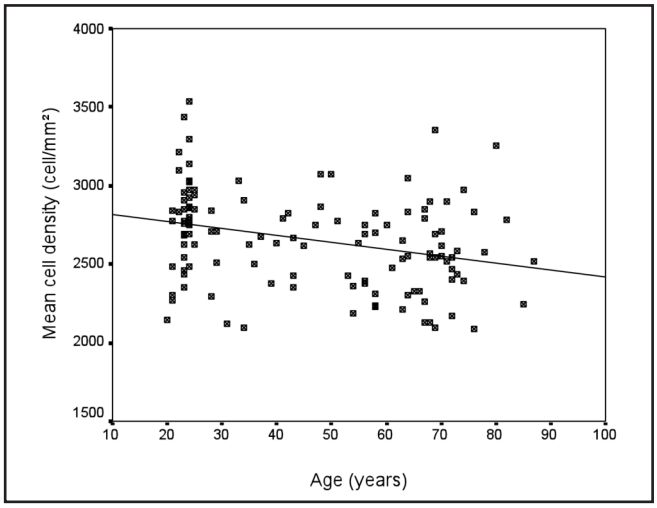

Fig. 1: Scatter plots shows correlation between the age and the mean cell density (MCD) (r = -0.30, p = 0.001).

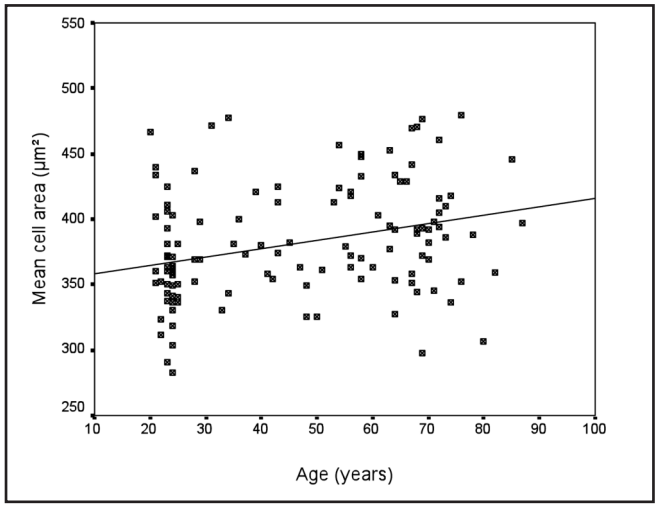

Fig. 2: Scatter plots shows correlation between the age and the mean cell area (MCA) (r = 0.30, p = 0.001).

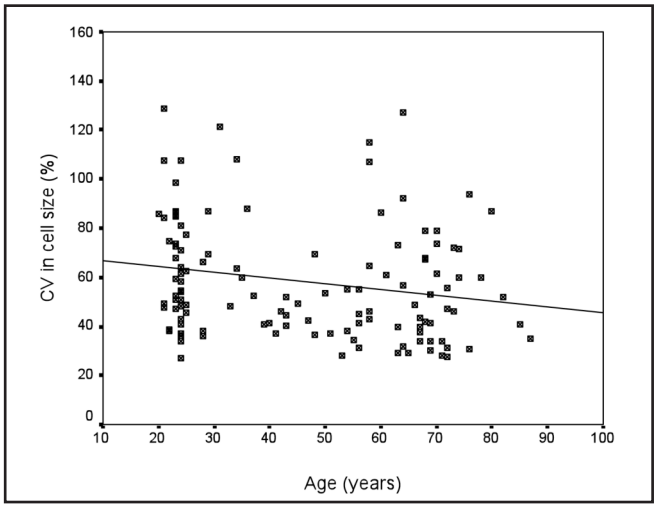

Fig. 3: Scatter plots shows correlation between the age and the CV in cell area (r = -0.20, p = 0.02).

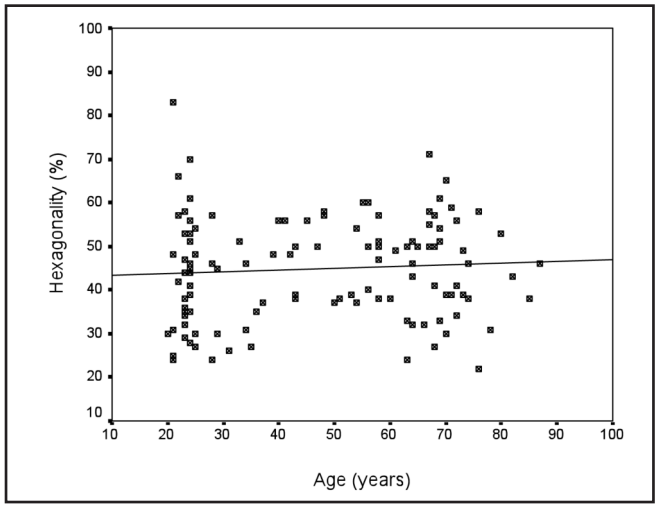

Fig. 4: Scatter plots shows correlation between the age and the hexagonality (r = 0.07, P = 0.41).

contiguous cells were marked manually and analyzed by a built-in software program. The mean cell density (MCD), mean cell area (MCA), coefficient of variation (CV) in cell size and hexagonality were automatically calculated and displayed. Statistical analysis of the data was performed using SPSS program.

RESULTS

Characteristics of corneal endothelial cells were studied in 125 Malay eyes. The mean age of the study population was 45.8 ± 20.7 years. Among the participants 51 were male and 74 were female.

The mean endothelial cell density (MCD) was 2648 ± 310 cell/mm² (range, 1677 – 3626) and the mean cell area (MCA) was 382.8 ± 47.7µm² (range, 275 - 596). The coefficient of variation (CV) in the cell size was 58.1 ± 22.6 (range, 26.8 – 134) and the percentage of hexagonal cells was 44.3 ± 11.5% (range, 22 - 83%).

Comparing endothelial cell density among different age groups of the study population, the MCD was noted to decrease from 2783 cell/mm² in the 20-30 years age group to 2570 cell/mm² in subjects aged 70 years and more (Table I).

The differences in the MCD between males and females in different age decades were insignificant *(P>0.5)* (Table II). Regression analysis showed an overall decline in the MCD with increasing age *(r = -0.30)* and a corresponding increase in MCA with increasing age *(r = 0.30)* (Table III). The regression analysis showed a significant correlation between the age and MCD *(r = -0.30, P = 0.001)*, MCA *(r = 0.30, P = 0.001)* as well as CV in cell size *(r = -0.20, P = 0.02)* (Figures 1,2,3), but the correlation between the age and cell hexagonality (Figure 4) was not significant *(r = 0.07, P = 0.41)*.

DISCUSSION

Several studies were conducted in the past to describe the characteristics of corneal endothelial cells of different races[4-8].

Subjects from the 20 to 30 year old age group were found to have the highest endothelial cell density compared to other age groups. Older age groups, specifically those over 70 years of age were found to have a lower corneal endothelial cell density, but this did not appear to affect corneal clarity.

The results of the current study concurred with the findings of the previous studies [5,7]. Hexagonality remained fairly constant throughout all age groups.

Comparison of endothelial cell density was performed between males and females to determine effect of the gender. Although we found slight difference between males and females, statistically it was not significant (P > 0.05). This finding was consistent with results reported in Chinese, American and Japanese eyes[4,6]. However, differences in endothelial cell density between genders were found to be significant in Filipino eyes[7].

The amount of endothelial cell loss with aging as reported in other studies ranges between 0.3-0.6 % per year [5,6,9,10]. A greater loss in endothelial cell loss was noticed in the younger subjects and this was assumed to be related to a redistribution phenomenon which occurs as eyes grow in size.

The values obtained from Malay eyes compared to those reported in other studies for other populations. We have found that the corneal endothelial cell density in Malays is less than that in Americans, Japanese, Chinese as well as Filipinos[4,6,7]. Endothelial cell density in our study population was comparable to that found in Indian and Thai population5,8 as shown in table IV.

In conclusion, this study provides normative data on corneal endothelial cell density and morphology in Malay eyes. The results of this study may serve as an indicator to the status of the corneal endothelium in normal Malay eyes.

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