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Original article

Age related changes in corneal morphological characteristics of healthy Pakistani eyes

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Abstract

Purpose: To determine the age related changes in corneal morphological characteristics in normal healthy adult Pakistani population.
Methods: Four hundred and sixty-four eyes of 232 healthy volunteers with ages between 10 and 80 years of either gender were included. Corneal endothelial cell density (CED), morphology and central corneal thickness (CCT) were evaluated in each subject with non-contact specular microscope (SP-3000 P, Topcon Corporation, Japan) and average of three readings per eye was used for final analysis. All the findings including demographic data, and corneal parameters were endorsed on a pre-devised proforma.
Results: Mean age of study population was 39.52 ± 18.09 years with 123 (53%) males and 109 (47%) females. Mean CED of study population was 2722.67 ± 349.67 cells/mm^2, while mean CCT was 505.72 ± 32.82 μm. Corneal morphological parameters among various age groups showed statistically significant difference in all parameters ($p < 0.01$). Correlation statistics revealed that CED ($r = -0.497$, $p < 0.01$), CCT ($r = -0.216$, $p < 0.01$) and hexagonality ($r = -0.397$, $p < 0.01$) decreased significantly with increasing age, while average cell size ($r = 0.492$, $p < 0.01$) and CV of size ($r = 0.454$, $p < 0.01$) increased with age.
Conclusion: This study showed that CED in Pakistani eyes was less than that reported in Chinese eyes, higher than Portuguese, Iranian and Indian eyes and comparable to the values in Turkish, Nigerian and Thai eyes.

Keywords: Specular microscopy, Corneal endothelium, Endothelial cell density, Central corneal thickness

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Introduction

A healthy cornea is of paramount importance in maintaining clarity of vision. Central corneal thickness (CCT) and corneal endothelial cell morphology are the two vital parameters in functional and morphological evaluation of cornea for diagnostic purposes and before any intraocular surgery. Corneal endothelium has a limited capacity for repair and damage to corneal endothelial cells is compensated by a combination of cell enlargement and cell spread to cover up for lost cells, resulting in a gradual decrease in endothelial cell density, increase in size of cells with increased cellular pleomorphism and decrease in hexagonality.[1–3]

Normal corneal endothelial cell density (CED) at birth ranges between 4000 and 5000 (cells/mm^2) that declines with aging at a rate of 0.3–0.6% per year with an approximate value of 2000–3000 cells/mm^2 in a normal adult eye.[1,4,5] It is now well established that CED decreases with age, trauma, refractive surgery, intraocular surgery, glaucoma, corneal dystrophies and diabetes mellitus.[1,5,6] CCT is another important parameter for corneal health as the intraocular pressure (IOP) depends on corneal thickness and CCT must be taken into consideration in evaluating glaucoma patients or suspects.

Various studies have confirmed that CED, CCT and morphology vary with age, gender, race and ethnicity.[2–5]

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Normative data regarding corneal morphological parameters in Pakistani population are limited. Ashraf et al. evaluated 450 eyes of 225 healthy Pakistani volunteers showed a mean CED of 2654 ± 341 cells/mm^2, with a decreasing cell counts as age increased.[7] Due to difference in endothelial morphological parameters among various population, races and ethnic groups, it is important to know the normative data of our population and effect of various factors on corneal morphology. The objective of this study was to determine the effect of age on CCT, CED, average cell size, coefficient of variation in cell size (CV), and percentage of regular hexagonal cells in normal healthy adult Pakistani population and to find out the relationship between endothelial cell parameters and other factors.

Material and methods

After approval of hospital ethical review committee, this prospective cross-sectional study was conducted at the Department of Ophthalmology, PNS Shifa Naval hospital Karachi, from August 2015 to November 2016. Four hundred and sixty-four eyes of 232 healthy volunteers with ages between 10 and 80 years of either gender were included in the study through non-probability convenience sampling. Subjects with refractive error of ≥± 1.00 diopters, history of intraocular surgery or trauma, corneal opacity or dystrophy, glaucoma, uveitis, use of contact lens, use of topical eye drops and diabetes mellitus were excluded. Calculated sample size was 218 based on the power (90%) to detect a difference in cell density of 75 cell/mm^2 using mean CED for normal population of 2654 ± 341 cell/mm^2 and $\alpha = 0.05$.[7] Written informed consent was obtained from each subject before enrollment and study was conducted in accordance with the Declaration of Helsinki. All the subjects were stratified into six groups on the basis of age that included <20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years and >60 years. All the participants underwent complete ocular examination including visual acuity assessment, auto refraction, slit lamp bio microscopic examination of anterior and posterior segment and non-contact IOP measurement. CED, morphology and CCT were evaluated in each subject with non- contact specular microscope (SP-3000 P, Topcon Corporation, Japan) by a single experienced examiner between 09:00 and 11:00 AM. Three images from central cornea of each eye were captured and 100 contiguous cells per image were included for analysis by built- in software. An average of three readings per eye was used for final analysis. All the findings including demographic data, and corneal parameters (CED, CCT, mean cell area (MCA), CV of cell size, percentage of hexagonal cells) were endorsed on a pre-devised proforma.

Statistical analysis of the data was done using SPSS version 13.0. All the data were tested for normality before analysis. Descriptive statistics i.e. means ± standard deviation (SD) for quantitative variables and frequencies and percentages for qualitative variables were used. The mean differences between independent samples for the two groups were assessed using the Student's two-sided *t*-test, and the paired Student's *t*-test was used to compare means of dependent samples. Means of more than two groups were compared using one-way analysis of variance (ANOVA). Pearson's correlation coefficient was used to establish correlations between age, CED, CCT, CV and hexagonality. A p value of ≤ 0.05 was considered significant.

Results

Data of 464 eyes of 232 healthy subjects were evaluated. Mean age of study population was 39.52 ± 18.09 years (range: 12–80 years). There were 123 (53%) males and 109 (47%) females. Mean CED of study population was 2722.67 ± 349.67 cells/mm^2 (range: 1700.9–3756.7 cells/mm^2), while mean CCT was 505.72 ± 32.82 μm (range: 409–606 μm). Mean average cell size, CV of cell size and hexagonality of study population are given in Table 1. The endothelial characteristics did not show significant difference between males and females or between right and left eyes except the CCT values that were significantly higher in females ($p < 0.01$) (Table 2). Corneal morphological parameters among various age groups showed statistically significant difference in all parameters ($p < 0.01$) (Table 3). Average corneal endothelial cells loss per decade was 87 cells/mm^2 that equals to approximately 0.28% cells loss per year (Table 3). The highest rate of loss was noted in the third decade of life in this study population (6.04%). Correlation statistics revealed that CED ($r = -0.497$, $p < 0.01$), CCT ($r = -0.216$, $p < 0.01$) and hexagonality ($r = -0.397$, $p < 0.01$) decreased significantly with increasing age, while average cell size ($r = 0.492$, $p < 0.01$) and CV of size ($r = 0.454$, $p < 0.01$) increased with age (Table 1). CED and CCT showed positive correlation ($r = 0.175$, $p < 0.01$) indicating high CED with thicker corneas.

Table 1. Corneal morphological parameters among various age groups.

Age group (years)	Age (years) mean ± SD	No of eyes	CCT (μm) mean ± SD	CED (cells/mm^2) mean ± SD	Avg cell size (μm^2) mean ± SD	CV of size (%) mean ± SD	Hexa (%) mean ± SD
<20	18 ± 2.09	84	518.20 ± 25.81	3021.24 ± 312.24	335.23 ± 35.67	29.86 ± 4.68	61.12 ± 10.26
21–30	23.70 ± 2.85	92	509.18 ± 37.56	2838.48 ± 264.59	355.76 ± 34.41	31.31 ± 3.68	59.09 ± 7.60
31–40	35.11 ± 3.59	74	495.08 ± 30.48	2706.80 ± 280.24	373.35 ± 40.33	34.60 ± 4.93	55.03 ± 7.75
41–50	44.09 ± 2.75	68	517.68 ± 21.51	2626.42 ± 280.31	385.78 ± 44.02	36.06 ± 4.07	52.46 ± 6.88
51–60	55.80 ± 2.96	82	498.99 ± 32.51	2555.16 ± 359.88	400.28 ± 58.46	35.75 ± 4.52	52.41 ± 7.64
>60	69.91 ± 6.29	64	492.61 ± 36.42	2499.59 ± 303.52	406.60 ± 50.81	35.78 ± 4.41	53.16 ± 8.55
Total	39.52 ± 18.09	464	505.72 ± 32.82	2722.67 ± 349.67	374.13 ± 50.75	33.67 ± 5.01	55.84 ± 8.55
p Value[a]	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01
Correlation[b] r (p value)	–	–	−0.216 (<0.01)	−0.497 (<0.01)	0.492 (<0.01)	0.454 (<0.01)	−0.397 (<0.01)

[a] ANOVA.
[b] Pearson's correlation.

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