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CORRELATION BETWEEN ENDOTHELIAL CELL DENSITY AND CENTRAL CORNEAL THICKNESS IN NORMAL ADULTS

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ABSTRACT

PURPOSE: *To check the correlation between endothelial cell density (ECD) and central corneal thickness (CCT) with a non-contact specular microscope in normal adults.*

METHOD: *This correlation cross-sectional study was conducted at Mayo Hospital from June 1 to October 30, 2019. This study included 30 healthy students of the College of Ophthalmology and Allied Vision Sciences. Both measurements were done on CSO SP-01 specular microscope. Data was collected by a self-designed Proforma. All the data were entered and analyzed using Statistical Software SPSS Version 21. Pearson correlation test was applied. Pearson coefficient value greater than 0.7 was considered as strong correlation.*

RESULTS: *The mean CCT and ECD of participants were 524.97±52.9 µm and 2449±370 cells/mm2, respectively. The relationship (r) between endothelial cell density and central corneal thickness was 0.344. There is a weak correlation between ECD and CCT.*

CONCLUSION: *It is concluded that there is a weak correlation between endothelial cell count and central corneal thickness in adults (r = 0.344).*

KEYWORDS: *Endothelial cell density, Central corneal thickness*

INTRODUCTION

Cornea is the transparent, outer layer of the eye that refracts incoming light onto the lens and then on retina. Cornea bends light on to the retina because it has high refractive power as compare to lens. As cornea contributes high power, any change in smoothness, curvature and thickness cause detrimental effects on vision.[1]

The cornea is an avascular, transparent structure that measures 10–11 mm vertically and 11–12 mm horizontally.[2] It has refractive index of 1.376. Its radius of curvature is often recorded as a spherocy lindrical convex mirror although the cornea is aspheric. Its central anterior surface is also called the corneal cap.[3] It provides 74%(43.25) diopters (D) of the total 58.60 dioptric power of a normal human eye.[2]

Cornea consists of five layers. The corneal epithelium makes up approximately 5%–10% of the total corneal thickness and is composed of stratified squamous epithelial cells. The clarity of the cornea depends partly on closely packed epithelial cells with minimal light scattering and uniform refractive index.[3] The corneal epithelium is an outer transparent tissue that acts as a barrier against external insults and regenerates through stem cells. The specialized compartmentalization of stem, progenitor, and differentiated cells into distinct regions makes the cornea a perfect model for stem cell biology. Corneal stem cells are present in the periphery of cornea known as limbus.[4]

The Bowman membrane, anterior elastic lamina and anterior limiting lamina are present between epithelium and stromal layer of the cornea of eye i.e. smooth cell layer and cannot be regenerated. The anterior surface of bowman's membrane faces the epithelial basement membrane and the posterior surface faces the collagen lamellae of corneal stroma. Corneal transparency is obtained due to the regular management of the stromal cells and macromolecules. They are adhesive fibroblasts located between the collagen lamellae.Corneal stroma is made of collagen fibrins and it is 90% of the thickness of cornea. Different techniques are used to describe the structure of cornea. In vertebrate corneas, stroma contains very thin (~32 nm diameter) collagen fibers, that combined together to form lamella.[5] Between stroma and endothelial layer of cornea, there is a basement membrane known as descemet's membrane. It is made up of two types of collagen i.e. Type IV and VIII.

The posterior part of the cornea contains endothelial layer. Endothelial layer of cornea is made of squamous epithelial cells which are responsible for the composition of Descemet's membrane. Endothelium is a single layer consisting of closely packed hexagonal cells, making the inner surface of cornea. This layer helps in sustaining the optimum hydration of cornea. Endothelial cell damage is usually caused by aging. Normal endothelial count is about 5,000cells/mm^2 at birth and 2,000cells/mm^2 in adult eye. Due to trauma, diseases, or intraocular surgery, if cell density falls below 500 cells/mm^2 that leads to corneal swelling. The repair function is limited to the swelling and sliding of the existing cells because of the limited capacity of cell division. Gravimetric analysis of the corneal endothelial cell morphology from image data gives useful information that helps ophthalmologists in investigation and treatment of corneal disorders. Currently, the most important method to assess the corneal health is endothelial cell density (ECD), expressed as number of cells per mm^2. Other parameters give uncertain evaluation, such as polymegethism – expressed in cell size by coefficient variant (CV) – or pleomorphism – quantified by the hexagonality coefficient (HEX) as a percentage of hexagonal cells – so they are not used in standard clinical practice.[6] The cell density and morphometry of the endothelium are measured with wide range of instruments.

The cornea endothelium utilizes the Na+/K+ pump. Along with an active metabolic pathway, it keeps the stroma at its usual hydrated state of 70 percent water to prevent stromal edema. The average normal corneal endothelial cell density is usually highest at birth (~3,000 cells/mm^2), and then decreases gradually. A minimum density of 400–500 cells/mm^2 is required to maintain the pumping activity of the endothelium, and values below this are associated with bullous keratopathy.[7]

Dry eye is the most common complain of patients to see an ophthalmic care provider and affects 5–35% of the population. Furthermore, we have recently observed that patients with moderate to severe dry eye have a significant decrease in central corneal endothelial cell density (CECD).[8]

Diabetes mellitus (DM) has long been known to have an effect on the function and morphology of the corneal endothelium. Several reports show a decreased ECD in diabetic patients, while some studies show no difference or even increased ECD.[9]

Normal central corneal thickness (CCT) is 490-560 µm and corneal thickness is greatest at limbus.[10] Keratoconus is an enteric corneal disorder in which gradual thinning of cornea occurs that leads to irregular astigmatism and reduced vision. Keratoconus may also be associated with Fuch's corneal endothelial dystrophy.[11]

MATERIALS AND METHOD

It was correlational cross-sectional study. The sample size was 30 individuals and all of them were the students of the College of Ophthalmology and Allied Vision Sciences (COAVS). The data were collected 6 months after the approval of the synopsis. Cooperative patients of both genders (18-30) years of age were included and the patients having non-fixating eyes, hazy cornea, any systemic ailment, and any ocular pathology were excluded. The equipment used was a specular microscope (CSO SP-01). Age, gender, and laterality were independent variables while ECD, CCT were dependent variables. Data was analyzed by SPSS 21 software. Pearson correlation test was applied.

RESULTS

Table 1: Endothelial Cell Density (ECD) and Central Corneal Thickness (CCT)

Descriptive Statistics						
	Statistic	Minimum	Maximum	Mean	Std. Error	Std. Deviation
ECD	30	1754	3047	2448.5	67.454	369.46
CCT	30	357	618	524.97	9.658	52.9

This table shows the mean CCT and ECD of the participant. The mean CCT and ECD were 524.97±52.9µm and 2448.50±369.46cells/mm2, respectively.

Table 2: ECD, CCT, and Age

Correlation				
		Age	ECD	CCT
Age	Pearson Correlation	1	-.073	.195
ECD	Pearson Correlation		1	.344

Explanation:

There is a weak positive relationship between ECD and CCT (.344).

There is a weak negative relationship between Age and ECD (-.073).

There is a weak positive relationship between Age and CCT (.195).

Figure 1: ECD and CCT

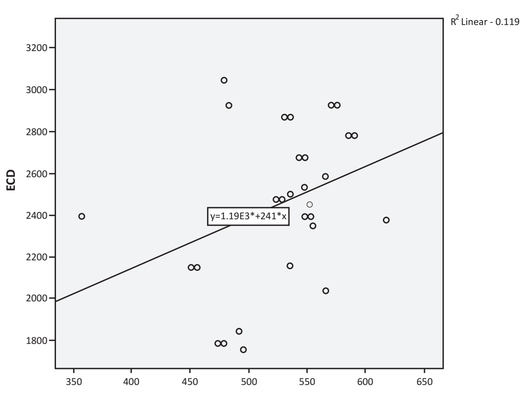


Figure 2: Age and CCT

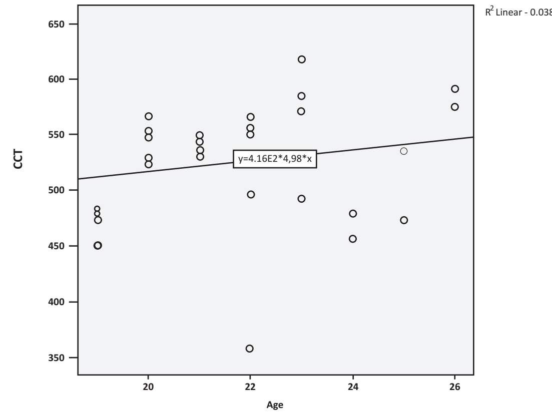
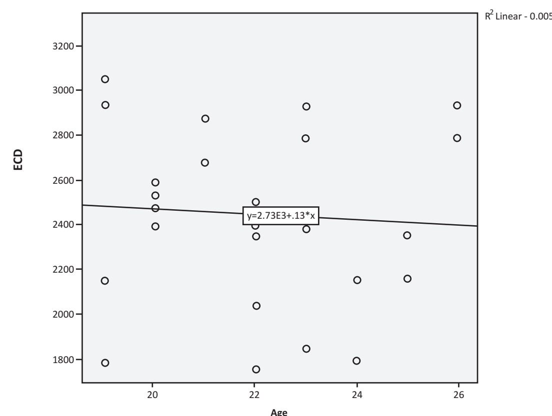


Figure 3 :Age and ECD



DISCUSSION

The corneal endothelial cells have no regenerative capacity.[12] Specular microscopy was done to check correlation between ECD and CCT. All participants were healthy students of COAVS, KEMU, Mayo Hospital, Lahore.

The mean CCT and ECD of participants were 524.97±52.9 µm and 2449±370 cells/mm^2, respectively. The relationship (r) between cell density and thickness was 0.344. There is a weak correlation between ECD and CCT. The mean age of female 21.00±1.534 years and male 23.00± 2.256 years, was respectively. The mean CCT was (511.67±56.193 µm and 538.27±47.540 µm, p=0.305) of right and left eye, respectively. The mean ECD was (2391.53±422.865cells/mm^2 and 2505.47±311.421 cells/mm^2, p=0.408) of left and right eye, respectively.

In a study, density and morphology of corneal endothelial cells in healthy Egyptian eyes were evaluated using a non-contact SM and no significance was detected in mean cell density between males and females. In addition, MCA increased with increasing age, whereas mean cell density decreased more easily with increasing age. A comparison with preceding studies suggests that the cell density is lower in Egyptian people than in the Chinese and Japanese community, and related to the Nigerian and American community. These studies examined the change in endothelial properties between other age groups and endothelium over a wide range of ages. The average central thickness was 517.06±38.41 µm. Central corneal thickness with age reduction was highest in the 20−30-year age group (525.90±47.65 µm). In this study, the correlation between corneal thickness and cell density was not significant(P = 0.069), as opposite to Nieider et al., who narrated a negative relationship between thickness and cell count, but Galgauskas stated that there was a direct connection of endothelial cell density and central corneal thickness, relating the upper cell density with thick cornea.[13]

In another study, Specular microscopy (Konan Noncon Robo NSP-7700) was performed to detect cell count and corneal thickness. An average of 3 readings was taken and patient was guided to look at the fixation target. Auto-adjustment function was used. All endothelial cells that were clearlyvisible on the picture are manually marked. Endothelial cell density (ECD) was calculated by the built-in software after marking 20 discrete points.[14]

In previous studies, CD decreased with increasing age in normal individuals. We found related outcome in the control group. Despite this there was no association between age and cell density in uveitic patients. This conclusion may be linked to the evidence that young patients in the uveitic group had more severe, late onset infection than the older patients.[15]

Some studies have recorded the correlation of cell density and structure with age, gender and race. One study reported the initial characteristics of the population in the Turkish population, which assist a valuable basis for subsequent studies. It observed a study decrease in in mean cell density (MCD) and percentage of hexagonal cells, as well as an increase in cell size (MCA) and cell size coefficient of variation (CV). There was no significant variance between cell charecteristics and central thickness between sexes and there was no statistically significant difference between the eyes of individuals. Comparability with previous studies indicate that cell density in Tuchises is lower than in Filipino, American, Japanese and Chinese eyes, despite, Turkish value is higher than that of Thai, Iranian and Indian eyes.[16]

CONCLUSION

It is concluded that non-contact specular microscope (CSO SP-01) has weak correlation between ECD and CCT. The Pearson correlation value for CCT and ECD is 0.344.

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