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Correlation of Myopia Degree with Central Corneal Thickness and Corneal Endothelial Density

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ABSTRACT

Introduction: The anterior segment characteristics that may contribute to myopia are central corneal thickness and corneal endothelial cell density. The purpose of this study is to ascertain whether corneal endothelial density and central corneal thickness are associated with the degree of myopia.
Methods: This cross-sectional observational analytical study was conducted from October to November 2018 at the Hasanuddin University Hospital in Makassar, Indonesia. Levior myopia (< -3.00 D) 61 eyes, moderate myopia (-3.00 D - -6.00 D) 30 eyes, and gravior myopia (> 6.00 D) 11 eyes comprised the 102 eyes of 65 myopic patients who participated in the study. The Snellen chart projector and trial lens set are used to test the refractive state of myopia. In contrast, the Nidek-CEM 530 specular microscope is used to measure the central corneal thickness and corneal endothelial cell density.
Results: The high myopia group had the lowest CCT mean (521.3um; p: 0.199). The group with high myopia had the lowest mean ECD, 2777.6 (p<0.05). In cases of moderate myopia, a correlation between corneal ECD and CCT was found (p<0.05).
Conclusion: The degrees of myopia and the CCT do not correlate. Reductions in corneal ECD are associated with myopia gravior. In moderate myopia, there is a strong positive relationship between corneal endothelial cell density and central corneal thickness.

Keywords: Myopia; refractive error; biometry

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Introduction

Ocular components including the cornea, aquos humor, lens, and vitreous humor, play a significant role in determining an individual's refractive status, especially the development of myopia. The cornea has been demonstrated to contribute approximately two-thirds of all optical refractive power, making it a crucial factor in the pathogenesis of myopia, although the precise causes of this condition remain elusive[1]. There is an ongoing debate regarding the contribution of the anterior segment in individuals with myopia. Retinal and scleral depletion, posterior staphyloma, choroidal atrophy, and a high rate of retinal detachment are among the most often observed abnormalities in myopia patients that affect the posterior region of the eye[2]. Prolonged myopia, compared to emmetropia, is recognized as a primary cause of various ocular disorders resulting from the elongation of the eye's axial length. According to Pederson L[3], and based on the basic stretching theory, the increase in axial length observed in myopic eyes, which resembles the inflation of a balloon, leads not only to thinning of the posterior segment but also affects the anterior segment, including the cornea. As a result, the cornea in individuals with myopia tends to be thinner than that in emmetropic individuals. Studies have also demonstrated that myopic patients exhibit structural alterations in the cornea, particularly a decrease in central corneal thickness compared with emmetropic eyes[4–8].

Methods

Study Design and Subject

This study uses a cross-sectional observational analysis. The study included participants with a clinical diagnosis of myopia who met the following inclusion criteria: aged between 20 and 40 years, with an anatomically normal anterior segment, and no history of contact lens use within approximately two weeks before examination. Exclusion criteria encompassed individuals who were pregnant or breastfeeding, had a history of intraocular surgery, glaucoma, ocular inflammation or infection, ocular trauma, systemic ocular disease, other significant ocular pathologies, or astigmatism exceeding 1 diopter.

Every patient of myopia underwent visual examination and correction using a Snellen chart projector and trial lens. Continued intraocular pressure examination using a non-contact tonometer and examination of the anterior segment of the eyeball with a slit lamp biomicroscope.

Patients with myopia who match with inclusion criteria are identified and given qn explanation of the research. The patients fill out and sign an informed consent form sheet. Samples were grouped into 3 groups according to their degree of myopia, levior / mild myopia (<-3.00 D), moderate / moderate myopia (-3.00 D to -6.00 D), and gravior / high myopia (> -6, 00 D). Then, measure the thickness of the central cornea using a specimen microscope, Nidek CEM-530.

Statistical Analysis

Data were analyzed using SPSS version 22. Results were presented narratively and in tables. Statistical tests employed included the Chi-square test, one-way ANOVA, and Pearson correlation to evaluate the association between independent and dependent variables. A p-value > 0.05 was considered not statistically significant, while p ≤ 0.05 was deemed statistically significant.

Result

Patient Characteristic

During the sampling period, 102 subjects from 65 samples, consisting of 17 men (16.7%) and 85 women (83.3%), were obtained by consecutive sampling. The mean age of the study subjects was 27.5 ± 5.1 years. CCT and ECD measurement results show that the CCT range is 469-599 µm with an average of 536.4 ± 29.7µm, and ECD shows a range between 1802.0-3428.0 with an average of 2931.8.4 ± 205.7 (Table 1).

Table 1. Descriptive Statistics of Age, Central Corneal Thickness (CCT), Endothelial Cell Density (ECD)

Variable	N	Min	Max	Mean± SD
Age (years)	102	20	40	27,5 ± 5,1
CCT (µm)	102	469,0	599,0	536,4 ± 29,7
ECD (cell/mm²)	102	1802,0	3428,0	2931,8 ± 205,7

Most of the subjects were 85 women (83.3%). Lateralization in the study subjects obtained 52 right eye samples (51.0%) and 50 left eyes (49%). The degree of myopia was divided into 3 groups, with mild myopia in 61 eyes (59.8%), 30 eyes were moderate (29.4%), and high myopia in 11 eyes (10.8%) (Table 2).

Table 2. Sample distribution characteristics.

Variable		N	%
Gender	Male	17	16,7
	Female	85	83,3
Eye	Right	52	51,0
	Left	50	49,0
Degree of Myopia	Mild	61	59,8
	Moderate	30	29,4
	High	11	10,8

Average Central Corneal Thickness (CCT) and Corneal Endothelial Cell Density (ECD) based on myopia degree.

The group with the highest degree of myopia had the lowest mean CCT and ECD, namely 521.3 ± 17.6µm and 2777.6 ± 374.6 cell / mm2, respectively. Based on the One-Way ANOVA statistical test, it was found that the difference in ECD values was statistically significant based on the degree of myopia (p <0.05), whereas on the CCT value, no significant difference was found (p = 0.199) (Table 3).

Table 3. Average CCT according to the degree of Myopia

Variable	Degree of Myopia			*P*
	Mild	Moderate	High	
CCT (µm)	538,7±30,9	537,2±29,7	521,3±17,6	0,199
ECD (c(cell/mm^2)	2936,0±152,7	2979,8±198,3	2777,6±374,6	0,018*

*significant difference using one-way ANOVA (P<0,05)

Correlation of Central Corneal Thickness (CCT) and Corneal Endothelial Cell Density (ECD).

Based on Pearson's correlation test, found a significant positive correlation between CCT and ECD (p <0.05) (Table 4 and figure 1), where the lower the CCT the lower the ECD, Mild and high myopia, no significant correlation was found (p> 0, 05) (Table 4).

Table 4. Correlation of CCT with ECD compared to the degree of Myopia.

Degree of Myopia	CCT	ECD	*R*	*P*
Mild	538,7±30,9	2936,0±152,7	0,119	0,360
Moderate	537,2±29,7	2979,8±198,3	0,422	0,020*
High	521,3±17,6	2777,6±374,6	-0,205	0,544

*significant using Pearson correlation test (P<0,05)

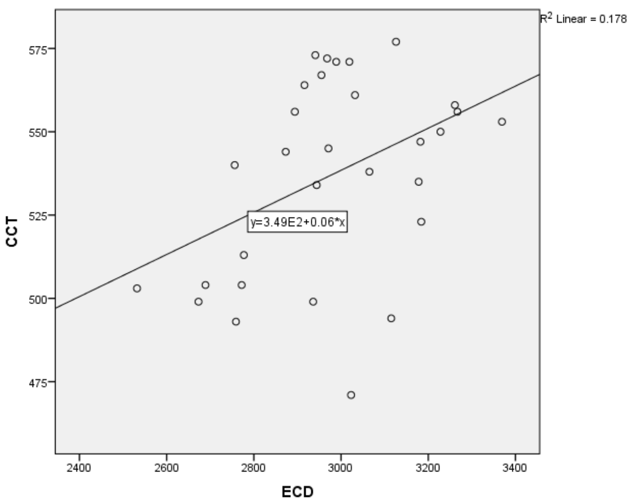

Figure 1. Correlation between CCT and degree of Myopia. Notes: Data were expressed in a scatter plot. Abbreviation: CCT, Central corneal thickness; ECD, Endothelial cell density.

Discussion

This study investigated the correlation between the degree of myopia, central corneal thickness (CCT), and corneal endothelial cell density (ECD) in Indonesian adults aged 20–40 years old. This age range was selected based on evidence from Grosvenor[9], which indicates that refractive status tends to stabilize during this period, reducing age-related confounding effects on biometric parameters.

The findings revealed no statistically significant differences in CCT across different degrees of myopia ($p = 0.199$). This aligns with several previous studies. Yi-Chun C et al. [10], in a large Taiwanese cohort, and Fam et al. [11], in a Singaporean population, similarly reported no significant association between CCT and the severity of myopia. These findings suggest that CCT may not be directly influenced by the degree of refractive error in myopic eyes. However, other studies have suggested otherwise. For instance, Bariah M et al. [12], Lene P et al. [13], and Hiromi H [14] reported weak or negative correlations between myopia severity and CCT. These discrepancies may be due to methodological differences or variations in population characteristics such as ethnicity or age distribution.

Theoretically, elongation of the eyeball in myopic individuals could exert mechanical stress on ocular structures, including the cornea. This axial elongation may thin the corneal stroma, consistent with the axial stretch model. Chang [15] and McBrien & Adams [16] have previously demonstrated that elongation of the vitreous cavity contributes to axial length increases, particularly in progressive myopia. However, this study did not include measurements of posterior segment parameters, such as axial length, thus limiting the ability to directly evaluate the effect of axial elongation on anterior segment structures.

Interestingly, a significant decrease in ECD was observed with increasing myopia severity ($p < 0.05$). This suggests that ECD may be more sensitive than CCT in reflecting structural changes associated with high myopia. Delshah and Jane C [17] similarly found significant reductions in ECD in patients with mild to moderate myopia. The underlying mechanism is likely related to the increased surface area of the corneal endothelium due to axial elongation. As postnatal corneal endothelial cells exhibit minimal mitotic activity, they are unable to replicate to cover the expanded area, resulting in a decreased cell density. This hypothesis is supported by previous reports from Landesz et al. [18] and Matsuda et al. [20], who described a reduction in ECD with increased axial length.

Furthermore, a significant positive correlation between CCT and ECD was identified, particularly in the moderate myopia group ($r = 0.422$, $p < 0.05$). This finding suggests that thinner corneas tend to be associated with lower endothelial cell density, which may have implications for clinical assessments of corneal health in refractive and surgical planning. Patel HY et al. [19] also reported similar findings in normal eyes, further supporting this relationship.

Variability in study outcomes across different populations may be influenced by factors such as age, gender, ethnicity, sample size, and measurement techniques. A key limitation of the present study is the lack of axial length measurements, which would have provided a more direct understanding of the impact of ocular elongation on corneal parameters. Future research incorporating both anterior and posterior segment analysis is recommended to provide a more comprehensive understanding of the structural changes associated with myopia progression.

Conclusion

This study found no significant association between the degree of myopia and central corneal thickness (CCT). However, endothelial cell density (ECD) showed a significant decrease with increasing myopia severity, and a positive correlation was observed between CCT and ECD, particularly in moderate myopia. These findings suggest that while CCT may not directly reflect myopia progression, ECD could serve as a more sensitive indicator of structural corneal changes in myopic eyes. More research including segment parameters is advised to clarify the fundamental mechanisms.

Conflicts of Interest

There is no conflict of interest

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