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Correlation between Central Corneal Thickness, Axial Length and Relative Lens Position with the Degree of Myopia in University of Sumatera Utara General Hospital and Affiliation Hospitals in Medan

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Abstract. *Introduction:* The prevalence of myopia has constantly increased in recent decades, indicating serious public health problems. Myopia has increased the risk of visual impairment globally.

Purpose: This study aims to analyze the correlation between central corneal thickness, axial length, and relative position with the degree of myopia in University of Sumatera Utara General Hospital and affiliation hospitals in Medan.

Materials and Methods: This study was an observational analytical study with cross-sectional design. Inclusion criteria were myopia patients with minimal age of 18 years old, myopia with spherical equivalent 0.25 or less, and agreed to participate in this study. Exclusion criteria were best corrected visual acuity less than 6/6, patients with systemic and ocular diseases, patients with unclear refractive media, patients with a history of ocular surgery. The measurements of this study were refraction status, central corneal thickness by pachymetry, ocular biometry by A-scan USG, and relative lens position. Data were analyzed using Kruskal-Wallis test, One Way ANOVA, and Bonferroni.

Result: A total of 70 eyes from 35 myopia patients were included in this study, most were female (54.3%). Mean age was 24.6±4.48 years. In this study, mean central corneal thickness was 525.97±27.22 µm, mean axial length was 24.65 mm±1.62 mm, and mean relative lens position was 2.01±0.18 µm. Most patients had lower myopia degree. There was a significant correlation between central corneal thickness and myopia degree in all subjects. There was a significant correlation between axial length and myopia degree in all subjects. There was a significant correlation between the relative lens position and myopia degree.

Conclusion: There was a correlation between the degree of myopia with the central corneal thickness, axial length, and relative lens position.

Keywords: Central Cornea Thickness, Axial Length, Relative Lens Position, Myopia

Introduction

Refractive disorder is one of the most sight threatening conditions and the second most progressive diseases leading to blindness. Refractive disorder that was not treated well will lead to moderate and severe visual impairment globally (Brodie, Gupta, & Irsch, 2019; Brar, Law, & Lindsey, 2019; Flaxman et al., 2017). The prevalence rate of myopia was reported 22.9% in 2000, 33.9% in 2020, and will increase to 49.8% in 2050, indicating half of half of global population will have myopia (Das, 2018; Chiang et al., 2020). Myopia prevalence in Indonesia has increased significantly up to 48,1% in adult aged more than 21 years old. Out of all Indonesia's region, Riau had the highest prevalence of myopia which is 21,6% (Saw et al., 2002). A study by Asrul in 2015 at Eye Clinic in Adam Malik General Hospital Medan revealed that there were 1.104 case of myopia patient or 56,84% of visiting patient (Asrul, 2015).

Myopia has increased incidence of vision threatening conditions such as open angle glaucoma, cataracts, retinal detachment and macula degeneration. Complications of myopia were found mostly in socially and economically active society, resulting in serious social and

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economic problems. All this had led myopia to the most prevalence ocular disorder and a public health concern (Turbert, 2019; Williams, & Hammond, 2019).

Cornea is a clear layer in the anterior of orbit, that differentiation in cornea will lead to pathological situation in the orbit. A study by Das in 2016 reveal that there was a correlation between size of the eye and the depletion of the cornea in patient with myopia. Myopia patient had cornea 0.018mm thinner than cornea in non myopia patient. The study also reported that there was a correlation between the axial length and the myopia degree, mainly because of long axial length causing high myopia (Das et al., 2016; Artal, 2017). Axial length in myopia has shown effect on the anterior and posterior segment of the orbit (Das et al., 2016). Lens has a major function to refract a light especially in accommodation. Ultrasonography biometry was widely used to calculate axial range of the orbit such as the central corneal thickness, axial length, and relative lens position. Using ultrasonography biometry, value of relative lens position was calculated 10 x ([ACD+0.5 (Lens Thickness]/Axial Length), in which will be the parameter in myopia and determine the complications of the disease (Artal, 2017; Yin et al., 2012; Loh et al., 2021).

This study aim to analyze the correlation between central corneal thickness, axial length, and relative position with the degree of myopia in University of Sumatera Utara General Hospital and affiliation hospitals in Medan.

Materials and Methods

This was an observational analytical study with cross-sectional design that approved by Health Research Ethical Committee of Medical Faculty, University of Sumatera Utara (registration number: 734/KEP/USU/2020). This study was conducted at the Refraction Division of Ophthalmology Department, University of Sumatera Utara General Hospital from November 2020 to January 2021. Myopic patients with spherical equivalent poorer than -0,25 D in both eyes and aged more than 18 years old were included in this study. Exclusions criteria are: (1) best corrected visual acuity poorer than 6/6; (2) history of severe ocular infection such as keratitis, scleritis, uveitis, endophthalmitis and paraorbitalsellulitis; (3) opacification of refraction media; (4) glaucoma; (5) refractive surgery history and (6) diabetes mellitus, hypertension, renal or hepatic failure. Written informed consent was obtained from participants. The sample population was counted by using Consecutive sampling formula, therefore the minimum subjects in this study were 25 subjects.

Participants who fulfill the criteria would get a visual acuity test using a Snellen chart at 6 m, then objective refraction using Righton SPEEDY-i Auto Refractometer/Keratometer was performed to obtain spherical equivalent data in both eyes. Spherical equivalent (SE) was calculated as spherical power plus half of the cylinder power. All participants are classified into three degrees of myopia: low myopia (-0.50 to -3.00 D), moderate myopia (-3.00 to -6.00 D) and high myopia (less than -6.00 D). Ocular biometry data such as axial length, lens thickness and anterior chamber depth, were obtained from NIDEK US-4000 Echoscan after 2% tetracaine eye drop instillation. Ofloxacin eyedrop as an antibiotic prophylaxis were given after ultrasonography examination. Central corneal thickness was measured using Optovue iVue pachmetry and relative lens position was calculated with the formula: 10 x ([ACD+0.5 (LT]/AL).

All data in this study were analyzed using univariate analysis in analyzing the characteristics of variable using the mean, median, standard deviation, minimum, and maximum for variables such as gender using the number (n) and percentage (%). Bivariate analysis was used to analyze the relationship between central corneal thickness, axial length, and relative lens position with the degree of myopia using Kruskal Wallis test, Posthoc analysis, One Way ANOVA and Bonferroni test with a significance level of 5%.

Results

A total of 70 eyes from 35 myopic patients aged 18-36 years old participated in this study. Demographic characteristics of participants were described in Table 1. Ocular biometry data of both eyes obtained by Nidek US-4000 Echoscan described in Table 2. Mean axial length was 24.65±1.62 mm, mean anterior chamber depth was 3.15±0.46, mean lens thickness was 3.59±0.25. The measurements of central corneal thickness was 525.97±27.22 µm. Relative lens position was 2.01±0.18.

Table 1. Demography characteristics of participants

Demography characteristics		
Gender	Frequency (n)	Percentage (%)
Male	16	45.7
Female	19	54.3
Age (years)	*Mean ± SD* 24.6 ± 4.48	*Med (min – max)* 24 (18 – 36)
Spheric Equivalent (D)	-3.81±3.10	-3 (-12.5 – -0.5)

Table 2. Axial length, anterior chamber depth, corneal thickness, central corneal thickness, relative lens position of myopic patients at University of Sumatera Utara General Hospital

Characteristics	**n = 70**
Axial length	
Mean±SD (mm)	24.65±1.62
Med (min – max) (mm)	24.31 (21.75 – 28.82)
Anterior Chamber Depth	
Mean±SD (mm)	3.15±0.46
Med (min – max) (mm)	3.12 (2.24 – 4.16)
Corneal thickness	
Mean±SD (µm)	3.59±0.25
Med (min – max) (µm)	3.59 (2.77 – 4.48)
Central Corneal Thickness	
Mean±SD (µm)	525.97±27.22
Med (min – max) (µm)	521.50 (475 – 599)
Relative Lens Position	
Mean±SD (µm)	2.01±0.18
Med (min – max) (µm)	2.02 (1.43 – 2.39)

Based on refractive examination, the majority group of myopia patients is in low myopia group. The degree of myopia was shown in Table 3. The correlation between central corneal thickness and degree of myopia was shown in Table 4. Central corneal thickness was significantly correlated to the degree of myopia ($p = 0.007$). The correlation between axial length and degree of myopia was shown in Table 5. Axial length was significantly correlated to the degree of myopia ($p < 0.001$). The correlation between relative lens position and degree of myopia was shown in Table 6. Relative lens position was significantly correlated to the degree of myopia ($p < 0.001$).

Table 3. Degree of myopia patients at University of Sumatera Utara General Hospital

Degree of Myopia	Frequency (n)	Percentage (%)
Mild	39	55.7
Moderate	13	18.6
Severe	18	25.7

Table 4. Correlation between central corneal thickness and degree of myopia

Degree of Myopia	n	Central Corneal Thickness, *Mean±SD*, µm	p	Posthoc	
				Moderate	Severe
Mild	39	518.70±25.67	0.007[a]	0.228[b]	0.001[b]
Moderate	13	532.15±34.56			0.522[b]
Severe	18	537.28±20.12			

Note: [a]*Kruskal Wallis,* [b]*Mann Whitney*

Table 5. Correlation between axial length and degree of myopia

Degree of Myopia	n	Axial length, *Mean±SD*, mm	p	Posthoc	
				Moderate	Severe
Mild	39	23.76±1.06	<0.001[a]	0.012[b]	<0.001[b]
Moderate	13	24.70±1.08			0.003[b]
Severe	18	26.53±1.32			

Note: [a]*Kruskal Wallis,* [b]*Mann Whitney*

Table 6. Correlation between relative lens position and degree of myopia

Degree of Myopia	n	Relative Lens Position, *Mean±SD*	p	Posthoc[b]	
				Moderate	Severe
Mild	39	2.09±0.14	<0.001[a]	0.035	<0.001
Moderate	13	1.95±0.13			0.802
Severe	18	1.89±0.22			

Note: [a]*One Way Anova,* [b]*Bonferroni*

Discussion

In this study, myopic female group (54,3%) was more than myopic male group (45,7%). The result was in line with previous studies that revealed female subjects were more than male subjects, mainly because female had more near-work activity and less outdoor activity, contributing to faster myopia progression compared to male (Arsa, 2019; Sofiani, & Santik, 2016; Kalangi, Rares, & Sumual, 2016; Lv, & Zhang, 2013).

The majority of the patients were in 18-36 years age group. The was in line with published literature by Arsa in 2019 and Atsari in 2020 that myopia patients mostly young adult aged under 40 years old (Arsa, 2019; Atsari, Ariesti, & Hidayat, 2020). Table 2 described axial length, anterior chamber depth, corneal thickness, central corneal thickness, and relative lens position in myopia patients. The longest axial length 28.82 mm and the shortest is 21.75 mm. This was in line with Arsa's study in 2019 at University of Sumatera Utara, Medan, Indonesia and Das's study in 2020 at India that concluded the axial length of myopia was 24.08±1.23 (Arsa, 2019; Das et al., 2020). Mean spherical equivalent of myopia patients in this study was 3.81±3.10 D. This was similar to Duan's study in 2019, and Mimouni's study in 2018 that revealed mean spherical equivalent was -3.5±1.4 D and 4.02 ± 2.17 D respectively (Duan et al., 2019; Mimouni et al., 2018). Mean anterior chamber depth of myopia patients was 3.15±0.46 mm. This was similar to Nakao's study in 2020, Wei's study in 2020, and

Nguyen's study in 2019 that revealed mean anterior chamber depth was 3.23±0.25 mm and 3.30±0.24 mm respectively (Nakao et al., 2020; Wei et al., 2020; Nguyen et al., 2019). The mean corneal thickness of myopia patients was 3.59±0.25 µm. This was similar to Shoji's study in 2019 that revealed the mean corneal thickness of myopia patients was 3.62±0.24 mm (Shoji et al., 2020). Mean central corneal thickness of myopia patients was 525.97±27.22 µm with the smallest was 475 µm and the biggest was 599 µm. This was similar with Arsa's study in 2020 that reveal central corneal thickness was 527-554 µm (Arsa, 2019). Mean relative lens position of myopia patients was 2.01±0.18. In normal eye, the lens position had a correlation with the axial length. Axial length and vitreous cavity length in myopia patients were significantly longer than the emetropia and hipermetropia patients ($p<0.001$), but the difference in anterior chamber depth was not significant ($p=0.427$) (Loh et al., 2021).

Table 3 showed the degree of myopia patients; mild myopia group had the highest percentage that was 55.7%, followed by high myopia group that was 25.7% and moderate myopia group that was 18.6%. The result was similar with Bella's study in 2020 that concluded percentage of mild myopia was higher compared to moderate myopia and high myopia consecutively 73.6%, 18.7% and 7.7% (Aliviana, 2020).

Table 4 described the correlation between central corneal thickness and the degree of myopia. Mean central corneal thickness was significantly correlated to myopia degrees; central corneal thickness in mild, moderate and high myopia was 518.70±25.76 µm, 532.15±34.56 µm, and 537.28±20.12 µm consecutively. Using Kruskal Wallis test, there was significant correlation between central corneal thickness and myopia degree ($p = 0.007$). This was relevant with Mimouni's study in 2017 that there was a correlation between central corneal thickness and myopia degree ($p<0.001$), and Bueno-Gimeno's study in 2014 that high myopia has thicker CCT than the moderate and mild myopia (Mimouni et al., 2018; Bueno-Gimeno et al., 2014).

Table 5 described the correlation between the axial length and degree of myopia. Mean axial length was significantly correlated to myopia degrees; axial length was 26.53±1.32 mm in high myopia, 26.53±1.32 mm in moderate myopia and 23.76±1.06 mm in mild myopia. Using Kruskal Wallis, there was significant correlation between axial length and myopia degree ($p<0.001$). Posthoc analysis with Mann Whitney showed that there was a significant correlation ($p=0.001$). This result was in line with Arsa's study in 2019 and Bella's study in 2020 that there was correlation between axial length and myopia degree ($p<0.05$) (Arsa, 2019; Aliviana, 2020).

Table 6 described the correlation between the relative lens position and degree of myopia. Mean relative lens position was significantly correlated to myopia degrees, relative lens position in high myopia was the smallest 1.89±0.22 mm compared to 1.95 ±0.13 mm in moderate myopia and 2.09±0.14.mm in mild myopia. Using One way ANOVA, there was significant correlation between relative lens position and myopia degree ($p< 0.001$). Posthoc analysis with Bonferroni reveal that there was significant correlation ($p<0.001$).

The fact that there was no statistically significant difference in anterior chamber depth ($p=0.427$) between the refractive status groups, indicating the characteristics of the anterior segment of myopia were similar to those of hypermetropia and emetropia. This was in contrast to the study by Yong in 2014 that showed no difference in relative lens position in the myopia sample group compared to the other groups (Yong et al., 2014).

Limitations of this study were this study had relatively small numbers of samples and the investigators could not provide detailed other contributing factors to each degree of myopia, central corneal thickness, axial length, and relative lens position.

Conclusion

Myopia is a refractive disorder that defined by the correlation between the strength of the optic with axial length, central corneal thickness, and relative lens position contributing to the

degree of myopia. There was correlation between the degree of myopia with the central corneal thickness, axial length, and relative lens position.

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Conflict of Interest

The author declare that there is no conflict of interest.

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