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RELATIONSHIP BETWEEN ANTERIOR CHAMBER DEPTH, AXIAL LENGTH, AND LENS THICKNESS WITH ENDOTHELIN-1 IN ADOLESCENT MYOPIA

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ABSTRACT

Objective:This study aimed to investigate the relationship between anterior chamber depth (ACD), axial length (AL), and lens thickness (LT) with serum endothelin-1 (ET-1) levels in adolescent patients with myopia.Methods:A cross-sectional analysis was conducted on 60 adolescents aged 10–19 years with myopia (≥ -0.5 D) at RS Prof. Chairuddin Panusunan Lubis from August 2024 to February 2025. Ocular biometric parameters (ACD, AL, LT) were measured using A-scan ultrasonography, and serum ET-1 levels were quantified using ELISA. Statistical tests included ANOVA and Pearson/Spearman correlation analyses.Results:A significant increase in axial length was observed with myopia severity ($p < 0.001$). No consistent differences in ACD and LT were found across severity groups, except for a significant variation in LT in the left eye ($p = 0.047$). ET-1 levels were inversely correlated with AL ($r = -0.271$, $p = 0.036$), with stronger inverse correlation in mild myopia ($r = -0.618$, $p = 0.004$) and a positive correlation in moderate myopia ($r = 0.600$, $p = 0.005$). No significant correlations were found between ET-1 and ACD or LT.Conclusion:The study reveals a significant inverse relationship between AL and ET-1 levels in adolescent myopia, suggesting potential vascular involvement in myopia progression. ET-1 may serve as a promising biomarker for early detection and monitoring of myopic changes.

Keywords: *Axial Length, Anterior Chamber Depth, Lens Thickness, Endothelin-1, Myopia, Adolescents*

INTRODUCTION

Myopia, or nearsightedness, is one of the most prevalent refractive errors globally, particularly affecting adolescents and young adults.1 Characterized by the inability to see distant objects clearly, myopia significantly impacts quality of life, academic performance, and productivity.2 The International Myopia Institute (IMI) estimates that nearly 50% of the global population—approximately 5 billion people—will be affected by myopia by 2050, underscoring its growing significance as a public health concern.3 In Southeast Asia, the prevalence is projected to exceed 60%, with rapid increases attributed to lifestyle changes such as reduced outdoor activities and prolonged screen time.4,5 In Indonesia, studies have shown a prevalence rate of 10– 20% among children and adolescents, revealing the urgent need for targeted interventions.6

The etiology of myopia is multifactorial, involving genetic predisposition, environmental factors, and ocular biometric changes. Axial length (AL) elongation is a primary anatomical factor influencing myopia progression, with studies indicating that even a 1 mm increase in AL can result in a 2.50 diopter increase in myopia severity.7 Anterior chamber depth (ACD) and lens thickness (LT) are additional ocular parameters that have been linked to refractive errors, potentially modulating the severity and progression of myopia.8,9 Furthermore, recent research has highlighted the role of endothelin-1 (ET-1), a potent vasoconstrictive peptide, in ocular vascular regulation and its potential association with myopia through its effects on intraocular hemodynamics.10

While the relationships between ACD, AL, and LT with myopia have been extensively studied, the interplay between these ocular biometric parameters and ET-1 levels remains underexplored, particularly in adolescents who are at a critical stage of myopia progression.11 Existing evidence suggests that elevated ET-1 levels could disrupt retinal blood flow and contribute to structural changes in the eye, potentially influencing myopia severity.12,13 However, the findings remain inconsistent across studies, warranting further investigation to elucidate these associations.

This study aims to evaluate the correlation between ACD, AL, LT, and ET-1 levels in adolescent myopia patients at RS Prof. Chairuddin Panusunan Lubis. By analyzing these relationships, this research seeks to enhance our understanding of myopia pathophysiology and inform strategies for early detection and management.

METHODS

Study Design and Participants

This study is a cross-sectional analytic study conducted at Prof. Chairuddin Panusunan Lubis Hospital, Medan, Indonesia, from August 2024 to February 2025. The study included adolescent patients diagnosed with myopia who underwent biometric examinations and serum Endothelin-1 (ET-1) level evaluation. Participants were recruited through quota sampling based on predefined inclusion and exclusion criteria.

RESULTS

This study evaluated the relationship between axial length (AL), anterior chamber depth (ACD), lens thickness (LT), and endothelin-1 (ET-1) levels among adolescent myopia patients at Prof. Chairuddin Panusunan Lubis Hospital. A total of 60 patients with varying degrees of myopia participated in the study. Measurements of AL, ACD, LT, and ET-1 levels were performed using

A-scan ultrasonography and ELISA techniques. The results were stratified by the

severity of myopia: mild, moderate, and severe.

The mean AL values increased significantly with myopia severity for both eyes ($p < 0.001$). In contrast, there were no significant differences observed in ACD or LT between the different severity groups ($p > 0.05$). Interestingly, a weak negative correlation was identified between AL and ET-1 levels in the overall group of myopia patients ($r = -0.271$; $p = 0.036$).

Table 1 Biometric Measurements Based on Myopia Severity

Variable	Degree of Myopia			p-Value
	Mild	Moderate	Severe	
AL OD, mm	22,32±1,81	26,28±0,71	27,76±1	<0,001*[a]
AL OS, mm	22,61±1,72	25,59±1,19	26,73±1,03	<0,001*[a]
ACD OD, mm	3,71 (2,94-6,37)	3,37±0,33	3,35±0,33	0,038*[b]
ACD OS, mm	3,45±0,4	3,32±0,34	3,44±0,36	0,465[a]
LT OD, mm	3,56±0,34	3,55±0,28	3,68 (2,85-3,88)	0,491[b]
LT OS, mm	3,64±0,31	3,45±0,21	3,47±0,22	0,047*[a]
Endothelin-1, pg/mL	47,65±17,27	41,51±11,63	41,05±11,15	0,240[a]

*p-value < 0.05 indicates statistically significant improvement in visual acuity aOneway Anova, bKruskal Wallis

The results indicate that axial length (AL) increases significantly as myopia severity progresses. This finding supports the understanding that axial elongation is a primary factor contributing to refractive errors, particularly in severe cases. Anterior chamber depth (ACD) varied slightly across the severity groups, but statistical differences were not consistent, suggesting that ACD alone may not be a significant determinant of myopia severity. Lens thickness (LT) demonstrated a unique trend, with significant differences in OS across myopia categories. These findings suggest that LT may adapt biomechanically in response to axial elongation, particularly in severe cases where it shows an increase, possibly to maintain refractive power.

The mean ET-1 levels varied by degree of myopia. Patients with mild myopia exhibited higher ET-1 levels compared to those with moderate or severe myopia. Specifically, in mild cases, there was a strong inverse correlation between AL and ET-1 ($r = -0.618$; $p = 0.004$). However, in moderate cases, the correlation shifted to a positive relationship ($r = 0.600$; $p = 0.005$), suggesting potential vascular compensation.

Table 2 Correlation Between Biometric Parameters and Endothelin-1 Levels

Variable	Correlation Coefficient (r)	p-value
Axial Length OD	-0.271	0.036*
Axial Length OS	-0.067	0.610
ACD OD	-0.126	0.338
ACD OS	0.156	0.235
LT OD	-0.008	0.950
LT OS	0.116	0.379

*p-value < 0.05 indicates statistically significant improvement in visual acuity

These findings demonstrate a complex relationship between axial elongation and ET-1 levels, while no significant associations were observed for ACD or LT with ET-1. The patterns suggest that ET-1 may reflect intraocular hemodynamic changes related to myopia severity.

DISCUSSION

This study evaluated the relationships between anterior chamber depth (ACD), axial length (AL), lens thickness (LT), and serum endothelin-1 (ET-1) levels in adolescent myopia patients, providing significant insights into ocular biometrics and vascular biomarkers.

The findings confirmed that AL progressively increased with the severity of myopia, consistent with observations by Tideman et al.7 and Du et al.6. Axial elongation is a hallmark of myopia, reflecting structural changes in the eye. A negative correlation ($r = -0.271$, $p = 0.036$) was observed between AL and ET-1 levels, supporting the hypothesis that axial elongation influences vascular remodeling in the context of high myopia.

In contrast, ACD did not show significant variations across myopia severity levels, differing from results by Bhardwaj and Rajeshbhai14 and Kaur et al.15, who reported a positive correlation between ACD and myopia severity. These discrepancies might arise due to sample variability or measurement differences.

Lens thickness (LT) showed variable results. Studies by Lu et al.9 and Han et al.11 suggested thinner lenses in high myopia due to axial elongation and anatomical changes. Powierza et al. 10 further reported reduced ET-1 levels in high myopia, with correlations between AL and ET-1 levels ($r = -0.255$). These results indicate that axial elongation in myopia affects LT and contributes to intraocular hemodynamic regulation.

Interestingly, our findings showed a different trend. For OD, LT in mild myopia was 3.56 ± 0.34 mm, slightly lower in moderate myopia at 3.55 ± 0.28 mm, and increased in severe myopia to 3.68 mm (range 2.85–3.88 mm). In OS, LT values significantly decreased in moderate myopia (3.45 ± 0.21 mm) but slightly increased in severe cases (3.47 ± 0.22 mm). This upward trend might represent a biomechanical lens adaptation to maintain refractive power despite progressive elongation.

ET-1 levels were lower in severe myopia, aligning with results by Powierza et al.10, who found reduced ET-1 levels in high myopia. Marlina et al.13 reported higher ET-1 levels in myopia patients, with weak positive correlations between ET-1 and myopia severity. These contrasting findings suggest diverse mechanisms affecting ET-1, potentially driven by individual and environmental factors.

In this study, ET-1 levels were inversely correlated with AL in mild myopia ($r = -0.618$, $p = 0.004$), suggesting vascular remodeling in early stages. In moderate myopia, a positive correlation ($r = 0.600$, $p = 0.005$) indicated compensatory mechanisms. No significant correlations were observed in severe myopia or between ET-1 levels, ACD, and LT, suggesting that ET-1 primarily reflects changes in axial elongation.

The findings underscore the significant role of AL in the pathophysiology of myopia and its vascular implications, with ET-1 emerging as a promising biomarker. Further research is warranted to explore ET-1's diagnostic potential in myopia.

CONCLUSION

This study highlights the significant correlations between axial length (AL) and serum endothelin-1 (ET-1) levels in adolescent myopia patients. A negative correlation was observed between AL and ET-1 in mild myopia cases, suggesting that elongation of axial

length contributes to a decrease in ET-1 levels. Interestingly, a moderate positive correlation emerged in moderate myopia cases, indicating potential compensatory vascular mechanisms. However, no significant correlations were found between anterior chamber depth (ACD) or lens thickness (LT) and ET-1 levels across all degrees of myopia.

The findings underscore the critical role of axial elongation in the pathophysiology of myopia and its potential vascular implications, with ET-1 serving as a promising biomarker. Further research, particularly with larger sample sizes and multi-center participation, is recommended to validate these associations and to explore the underlying mechanisms more comprehensively.

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