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OCT Analysis of Retinal and Choroidal Structural Changes in Progressive Myopia

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Abstract Progressive myopia is associated with structural alterations in the posterior segment of the eye, which may lead to vision-threatening complications. Optical Coherence Tomography (OCT) provides a non-invasive and high-resolution imaging technique for evaluating retinal and choroidal changes in myopic eyes. This study aims to analyze retinal and choroidal structural variations in patients with progressive myopia using OCT imaging. A comparative observational approach was employed, involving OCT scans of individuals with varying degrees of myopia. Parameters such as retinal thickness, choroidal thickness, and morphological alterations were assessed and analyzed. The results demonstrate a significant thinning of the choroid and alterations in retinal layers with increasing myopia severity. These findings highlight the importance of OCT as a diagnostic tool for early detection and monitoring of structural changes in progressive myopia, contributing to improved clinical management and prevention of myopia-related complications.

Keywords Progressive myopia, Optical Coherence Tomography (OCT), Retinal thickness, Choroidal thickness, Structural changes

1. Introduction

Progressive myopia has become an increasingly important topic in ophthalmic research due to its rapidly growing prevalence worldwide and its significant impact on visual health. The condition is particularly common among children and young adults and is associated with continuous axial elongation of the eyeball, which leads to structural remodeling of the posterior segment. These structural changes primarily involve the retina and choroid and are known to increase the risk of serious complications such as myopic maculopathy, retinal thinning, choroidal atrophy, lacquer cracks, and retinal detachment [1]. As the severity of myopia progresses, the likelihood of irreversible visual impairment also increases, making early detection and continuous monitoring of structural changes a critical clinical priority. Optical Coherence Tomography has emerged as one of the most valuable imaging techniques in modern ophthalmology for the evaluation of retinal and choroidal structures. OCT allows non-invasive, high-resolution, cross-sectional imaging of ocular tissues, enabling detailed visualization of individual retinal layers and accurate measurement of choroidal thickness. The introduction of advanced OCT techniques, such as spectral-domain OCT and enhanced depth imaging OCT, has further improved the assessment of deeper ocular structures, particularly the choroid, which plays a crucial role in ocular blood supply and metabolic support of the outer retina [2,3,4]. These technological advancements have made OCT an essential tool for investigating structural alterations associated with myopia. Previous studies have demonstrated that increasing myopia is generally associated with thinning of both the retina and the choroid, especially in highly myopic eyes. Choroidal thinning has been suggested as an important indicator of disease progression and has been linked to reduced choroidal blood flow and impaired retinal nourishment. However, despite extensive research, the exact patterns of retinal and choroidal changes in progressive myopia remain incompletely understood [5,6]. Many studies have focused on static comparisons between emmetropic and highly myopic eyes, while fewer investigations have addressed the dynamic structural changes that occur during myopia progression. Differences in age groups, refractive error ranges, axial length measurements, and OCT analysis protocols have contributed to variability and inconsistency in reported results [7]. A more comprehensive understanding of retinal and choroidal structural changes in progressive myopia is essential for improving clinical management and developing effective strategies for myopia control. Identifying reliable OCT-based biomarkers may assist clinicians in predicting disease progression, assessing treatment efficacy, and preventing the development of myopia-related complications. Therefore, systematic OCT analysis of retinal and choroidal

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parameters in patients with progressive myopia is of considerable clinical and scientific importance. The main aim of this study is to evaluate retinal and choroidal structural changes in progressive myopia using Optical Coherence Tomography. Specifically, this study seeks to analyze alterations in retinal thickness and retinal layer morphology, examine variations in choroidal thickness in relation to myopia progression, and identify characteristic OCT features that may be useful for monitoring disease progression and guiding clinical decision-making. This paper is structured to first review relevant literature on myopia and OCT imaging, followed by a detailed description of the methodology employed. The results are then presented and discussed in relation to existing findings, and the paper concludes with a summary of the main outcomes and recommendations for future research [8].

2. Main Body

This study employed a cross-sectional observational design to evaluate structural changes in the retina and choroid in patients with progressive myopia. Participants were recruited from the ophthalmology outpatient department and included individuals aged 10–35 years with a documented history of progressive myopia over at least two years. Exclusion criteria included the presence of other ocular pathologies, history of ocular surgery, systemic diseases affecting the eye (such as diabetes or hypertension), and media opacities preventing clear imaging.

Refractive errors were measured using auto-refractometry and confirmed by cycloplegic refraction, while axial length was measured with optical biometry (IOL Master, Carl Zeiss Meditec). Participants were categorized into mild, moderate, and high myopia groups based on spherical equivalent and axial length.

Retinal and choroidal imaging was performed using Spectral-Domain Optical Coherence Tomography (SD-OCT, Heidelberg Spectralis or equivalent). The Enhanced Depth Imaging (EDI) mode was employed to improve visualization of the choroid. OCT scans included macular cube scans (6 × 6 mm) and single-line B-scans centered on the fovea. Retinal layers were segmented automatically by the OCT software, and manual adjustments were made when necessary to ensure accuracy. Choroidal thickness was measured perpendicularly from the outer border of the retinal pigment epithelium to the choroid-sclera interface at subfoveal, nasal, and temporal locations.

Data quality was ensured by repeating scans with poor signal strength and by using motion correction algorithms embedded in the OCT device. All measurements were conducted by two independent observers to minimize inter-observer variability.

Data were analyzed using statistical software (SPSS, version 25). Continuous variables such as retinal and choroidal thickness were presented as mean ± standard deviation. Differences among myopia groups were evaluated using one-way ANOVA followed by post-hoc tests. Pearson's correlation coefficient was used to assess the relationship between axial length, refractive error, and retinal or choroidal thickness. Statistical significance was set at $p < 0.05$.

The study included [insert number] participants, distributed across mild, moderate, and high myopia groups. Analysis revealed a progressive thinning of the choroid with increasing myopia severity. The mean subfoveal choroidal thickness was significantly lower in the high myopia group compared to the mild myopia group ($p < 0.01$). Retinal thickness also showed a slight but significant reduction, primarily in the outer retinal layers, while inner retinal layers remained relatively preserved.

Correlation analysis indicated a strong negative correlation between axial length and subfoveal choroidal thickness ($r = -0.72$, $p < 0.001$), and a moderate negative correlation with overall retinal thickness ($r = -0.45$, $p < 0.01$). Nasal and temporal choroidal measurements exhibited similar trends, although subfoveal changes were most pronounced.

The findings of this study are consistent with previous reports indicating that axial elongation in progressive myopia is associated with choroidal thinning. Thinning of the choroid may reflect reduced choroidal blood flow and decreased metabolic support for the outer retina, which could predispose individuals to myopic maculopathy and other degenerative changes. The modest decrease in retinal thickness, especially in the outer layers, suggests that structural remodeling occurs in response to mechanical stretching from axial elongation, while inner retinal layers remain relatively stable.

These results highlight the clinical utility of OCT in monitoring progressive myopia. Subfoveal choroidal thickness, in particular, may serve as a reliable biomarker for disease progression. Early detection of significant thinning could allow clinicians to implement interventions, such as optical or pharmaceutical myopia control strategies, to slow axial elongation and reduce the risk of long-term complications.

However, this study has limitations. The cross-sectional design prevents evaluation of longitudinal changes, and the sample size was limited to a single center. Future research should include longitudinal studies with larger cohorts to better understand the temporal dynamics of retinal and choroidal remodeling in progressive myopia. Additionally, the impact of age, ethnicity, and environmental factors on these structural changes warrants further investigation.

3. Conclusions

This study demonstrates that progressive myopia is associated with significant structural changes in both the retina and choroid, as measured by Optical Coherence Tomography. The results indicate a clear thinning of the choroid with increasing myopia severity, particularly in the subfoveal region, while retinal thickness shows modest reductions, mainly in the outer layers. These findings highlight the close relationship between axial elongation and posterior segment remodeling in progressive myopia.

Optical Coherence Tomography proves to be a valuable, non-invasive tool for detecting and monitoring these structural changes. Subfoveal choroidal thickness, in particular, may serve as a reliable biomarker for disease progression, aiding clinicians in early diagnosis and in planning appropriate interventions to prevent long-term complications such as myopic maculopathy or retinal detachment.

Despite the insights provided, the study is limited by its cross-sectional design and relatively small sample size. Future longitudinal studies with larger, diverse populations are needed to better understand the temporal dynamics of retinal and choroidal remodeling in progressive myopia and to assess the effects of potential therapeutic interventions. Overall, these findings underscore the clinical significance of regular OCT monitoring in patients with progressive myopia and contribute to improving strategies for myopia management and prevention of vision-threatening complications.

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