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ORIGINAL ARTICLE

DYNAMICS OF CHANGES IN ANATOMICAL AND PHYSIOLOGICAL OCULAR PARAMETERS IN PATIENTS WITH CONGENITAL MYOPIA

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Abstract

Congenital myopia is a complex refractive disorder characterized by the presence of myopia at birth or during early infancy and is frequently associated with progressive anatomical and physiological alterations of the eye. The condition affects multiple ocular structures, including the cornea, sclera, retina, choroid, vitreous body, and optic nerve, resulting in significant changes in visual function and ocular development. Monitoring the dynamics of ocular parameters is essential for understanding disease progression, predicting visual outcomes, and optimizing therapeutic interventions. Anatomical changes are primarily associated with axial elongation of the eyeball, thinning of retinal and choroidal tissues, scleral remodeling, and modifications of optic disc morphology. Physiological alterations include changes in accommodation, retinal sensitivity, visual acuity, binocular function, and ocular blood flow. These processes may progress throughout childhood and adolescence, increasing the risk of pathological complications such as retinal degeneration, posterior staphyloma, macular abnormalities, and retinal detachment. Modern diagnostic technologies, including optical coherence tomography, ocular biometry, ultrasonography, fundus imaging, and electrophysiological testing, enable detailed assessment of disease dynamics. This study evaluates the changes in anatomical and physiological ocular parameters observed in patients with congenital myopia and examines their relationship with disease progression, visual function, and long-term prognosis. The findings emphasize the importance of continuous monitoring and early intervention to preserve visual health and reduce the risk of severe ocular complications.

Keywords: Congenital myopia, axial length, ocular biometry, retinal thickness, choroidal thickness, visual acuity, accommodation, ocular development, pediatric ophthalmology, pathological myopia.

1. Introduction

Congenital myopia represents a distinct clinical entity within the spectrum of refractive disorders and differs significantly from acquired childhood myopia in its onset, pathogenesis, and progression. The condition is typically present at birth or becomes evident during the first months of life and may influence ocular development during critical periods of visual maturation. Because normal visual

function depends upon coordinated growth and development of multiple ocular structures, congenital myopia has the potential to affect both anatomical integrity and physiological performance of the visual system.

The development of congenital myopia is commonly associated with abnormal elongation of the ocular globe. Excessive axial growth results in displacement of the retinal focal plane and produces persistent retinal defocus. Over time, this process may lead to extensive structural remodeling involving the sclera, choroid, retina, and optic nerve. Such changes are particularly pronounced in patients with high congenital myopia, where progressive elongation of the eye can result in irreversible degenerative alterations and substantial visual impairment.

Anatomical modifications observed in congenital myopia include increased axial length, posterior pole stretching, thinning of retinal layers, reduction in choroidal thickness, optic disc changes, and alterations of vitreoretinal relationships. These structural abnormalities are often accompanied by physiological disturbances affecting visual acuity, accommodative responses, retinal sensitivity, contrast perception, binocular coordination, and ocular hemodynamics. The interaction between anatomical and functional changes determines the clinical course of the disease and influences long-term visual prognosis.

Advances in ophthalmic imaging and diagnostic technology have greatly improved the ability to investigate ocular development in patients with congenital myopia. Techniques such as optical coherence tomography, optical biometry, fundus photography, scanning laser ophthalmoscopy, and electrophysiological testing provide valuable information regarding disease progression and structural integrity. These methods facilitate early detection of pathological changes and support individualized management strategies.

Understanding the dynamic relationship between anatomical alterations and physiological dysfunction is essential for improving patient outcomes. Comprehensive evaluation of these parameters contributes to more accurate prognosis, timely intervention, and effective prevention of vision-threatening complications associated with congenital myopia.

2. Materials and Methods

This study was based on a comprehensive review of scientific publications, longitudinal cohort studies, clinical investigations, pediatric ophthalmology guidelines, and observational research examining anatomical and physiological changes in patients with congenital myopia.

The analyzed literature included studies evaluating ocular biometry, axial length measurements, corneal characteristics, retinal morphology, choroidal thickness, optic nerve structure, accommodative function, visual acuity, retinal electrophysiology, and ocular blood flow parameters. Diagnostic modalities included cycloplegic refraction, A-scan ultrasonography, optical biometry, optical coherence tomography, fundus imaging, fluorescein angiography, and electrophysiological assessments.

Comparative evaluation was performed according to age, degree of myopia, disease progression, structural alterations, functional outcomes, and occurrence of ocular complications. Longitudinal data were analyzed to identify patterns of anatomical growth and physiological adaptation associated with congenital myopia.

3. Results

Analysis of available clinical evidence demonstrated that axial elongation represents the most consistent anatomical change observed in patients with congenital myopia. Numerous studies reported significantly greater axial lengths compared with age-matched individuals without refractive abnormalities. Progressive elongation was particularly pronounced in patients with moderate and high myopia and was strongly associated with increasing refractive error over time.

Retinal imaging studies revealed progressive thinning of retinal tissues, especially within the posterior pole and macular regions. Structural changes became more evident with increasing age and severity of myopia. Choroidal thickness measurements demonstrated substantial reductions compared with healthy controls, suggesting impaired vascular support and altered metabolic conditions within the posterior segment of the eye.

Optic nerve evaluation frequently identified enlargement of the optic disc, peripapillary atrophy, disc tilting, and alterations of nerve fiber layer architecture. These findings were more common among

patients with advanced axial elongation and were associated with increased susceptibility to future visual complications.

Assessment of physiological parameters demonstrated significant variability depending on disease severity. Visual acuity was generally reduced in patients with uncorrected or inadequately corrected congenital myopia. Accommodation abnormalities were frequently observed, particularly among children with high refractive errors. Retinal sensitivity measurements indicated reduced functional performance in areas affected by structural degeneration.

Electrophysiological investigations revealed subtle disturbances in retinal function, particularly in patients with progressive forms of congenital myopia. Alterations in visual evoked potentials and electroretinographic responses suggested involvement of both retinal and neural visual pathways. Ocular blood flow studies also demonstrated reductions in choroidal and retinal perfusion, potentially contributing to progressive tissue degeneration.

Longitudinal observations confirmed that anatomical changes generally preceded the development of significant functional impairment. Continuous monitoring enabled early identification of patients at increased risk for pathological progression and facilitated timely implementation of therapeutic interventions.

4. Discussion

The findings demonstrate that congenital myopia is not merely a refractive disorder but rather a complex developmental condition involving extensive structural and functional alterations throughout the eye. Axial elongation appears to represent the central mechanism driving disease progression and serves as a major determinant of both anatomical remodeling and physiological dysfunction. The strong relationship between ocular growth and refractive change highlights the importance of monitoring axial length as a key indicator of disease activity.

Progressive thinning of retinal and choroidal tissues represents a significant concern because these structures play essential roles in maintaining visual function. Reduction of choroidal thickness may impair nutrient delivery and metabolic support to retinal tissues, contributing to degenerative changes and increased susceptibility to pathological complications. Similar observations have been reported in studies of pathological myopia, suggesting common mechanisms underlying tissue degeneration.

The presence of optic nerve alterations further emphasizes the systemic impact of excessive ocular elongation. Structural changes involving the optic disc and peripapillary region may influence visual function and complicate long-term disease management. Careful monitoring of these parameters is therefore necessary, particularly in patients demonstrating rapid progression.

Physiological disturbances observed in congenital myopia reflect the consequences of ongoing anatomical remodeling. Reduced visual acuity, impaired accommodation, altered retinal sensitivity, and changes in electrophysiological responses collectively contribute to functional limitations. These findings reinforce the importance of early optical correction and comprehensive visual rehabilitation to support normal visual development.

Modern imaging technologies have significantly improved understanding of disease dynamics and allow detailed evaluation of structural and functional relationships. Optical coherence tomography, in particular, has become an invaluable tool for detecting subtle retinal and choroidal changes before the appearance of overt clinical symptoms. Such technologies facilitate earlier intervention and improve opportunities for preserving visual function.

Future research should focus on identifying molecular mechanisms responsible for ocular elongation, developing effective strategies to control structural progression, and improving methods for preventing degenerative complications. Advances in pharmacological treatment, myopia control interventions, and regenerative therapies may offer new possibilities for managing congenital myopia and improving long-term outcomes.

5. Conclusion

Congenital myopia is associated with progressive changes in both anatomical and physiological ocular parameters that significantly influence visual development and long-term ocular health. Axial elongation represents the primary structural alteration and contributes to retinal thinning, choroidal reduction, optic nerve changes, and increased risk of degenerative complications. Physiological

disturbances involving visual acuity, accommodation, retinal function, and ocular blood flow frequently accompany these anatomical modifications. Continuous monitoring through modern diagnostic technologies enables early detection of pathological progression and supports individualized treatment planning. Early intervention, regular ophthalmological follow-up, and comprehensive management strategies are essential for preserving visual function and reducing the burden of long-term complications in patients with congenital myopia.

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