AAMS Surgery & Clinical Practice
ISSN: 2834-7190 (Print) | eISSN: 2834-7191 (Online)
Volume 02, Issue 05, Pages 1-15
DOI: 10.4103/aams.0498
ORIGINAL ARTICLE

STRUCTURAL AND FUNCTIONAL CHANGES IN EPIRETINAL MEMBRANE: CLINICAL AND TOMOGRAPHIC ASSESSMENT

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Received: 2026-03-11 · Accepted: 2026-04-23

Abstract

Epiretinal membrane (ERM) is a vitreoretinal interface disorder characterized by the formation of fibrocellular tissue on the inner retinal surface, leading to progressive structural distortion of the macula and impairment of visual function. The prevalence of ERM increases with age and represents an important cause of visual morbidity among elderly populations. Recent advances in optical coherence tomography (OCT) have significantly enhanced the ability to detect and evaluate retinal changes associated with ERM. The aim of this study was to investigate structural and functional alterations occurring in patients with epiretinal membrane through comprehensive clinical and tomographic assessment. A detailed analysis of retinal morphology, visual acuity, macular thickness, and vitreoretinal interface abnormalities was performed. The findings demonstrated significant associations between retinal structural distortion and deterioration of visual performance. OCT proved highly effective for early diagnosis, monitoring disease progression, and evaluating the severity of retinal changes. Clinical and tomographic correlation provides valuable information for therapeutic decision-making and long-term management of patients with epiretinal membrane.

Keywords: epiretinal membrane, optical coherence tomography, OCT, macular disorders, retinal thickness, vitreoretinal interface, visual acuity, retinal traction, ophthalmology, retinal imaging.

1. Introduction

Epiretinal membrane is one of the most frequently encountered disorders affecting the vitreoretinal interface and macular region of the eye. The condition is characterized by the development of a thin fibrocellular layer on the inner retinal surface, which gradually contracts and exerts tractional forces on the underlying retinal tissue. These mechanical changes may lead to progressive distortion of retinal architecture and impairment of central visual function.

The prevalence of epiretinal membrane increases significantly with advancing age. Population-based studies have demonstrated that the condition affects a considerable proportion of individuals older than sixty years and is becoming increasingly important due to the global aging population. Although some cases remain asymptomatic for prolonged periods, progressive membrane contraction may result in visual disturbances that negatively affect daily activities and quality of life.

The pathogenesis of epiretinal membrane is closely associated with age-related vitreous changes and posterior vitreous detachment. During this process, microscopic defects may develop on the retinal

surface, allowing migration and proliferation of glial cells, retinal pigment epithelial cells, fibroblasts, macrophages, and myofibroblasts. These cellular elements contribute to the formation of contractile fibrocellular tissue capable of altering retinal morphology.

Structural retinal changes induced by epiretinal membrane include thickening of the macula, distortion of the foveal contour, retinal wrinkling, disruption of retinal layer organization, and tractional deformation of photoreceptor structures. Such abnormalities may compromise retinal function and lead to visual symptoms including decreased visual acuity, metamorphopsia, micropsia, reduced contrast sensitivity, and impaired reading performance.

Clinical evaluation of epiretinal membrane has undergone substantial evolution over recent decades. Traditional diagnostic methods, including ophthalmoscopy and fundus photography, provide valuable information regarding membrane appearance but may underestimate the extent of underlying retinal changes. Consequently, objective imaging modalities have become increasingly important for comprehensive assessment.

Optical coherence tomography has revolutionized retinal diagnostics by providing high-resolution cross-sectional images of retinal structures. The technology allows detailed visualization of the vitreoretinal interface and enables accurate measurement of retinal thickness, identification of tractional abnormalities, and assessment of retinal layer integrity. OCT has become the gold standard for evaluating epiretinal membrane and monitoring disease progression.

The relationship between structural retinal alterations and functional visual impairment remains a subject of considerable clinical interest. While some patients demonstrate significant anatomical abnormalities with minimal symptoms, others experience substantial visual dysfunction despite relatively modest structural changes. Understanding this relationship is essential for determining appropriate treatment strategies and predicting visual outcomes.

Modern clinical management of epiretinal membrane requires careful integration of anatomical and functional data. Assessment of visual acuity, retinal sensitivity, patient-reported symptoms, and tomographic findings contributes to individualized therapeutic planning. Surgical intervention may be indicated in cases demonstrating progressive visual deterioration or significant retinal distortion, whereas stable asymptomatic membranes may be managed conservatively.

The present study aims to evaluate the structural and functional changes associated with epiretinal membrane through comprehensive clinical examination and optical coherence tomography. Particular attention is directed toward identifying tomographic biomarkers of disease severity and analyzing their relationship with visual performance in affected patients.

2. Materials and Methods

This prospective observational study was conducted between 2023 and 2025 at specialized ophthalmology clinics and retinal diagnostic centers. The primary objective was to evaluate structural and functional changes associated with epiretinal membrane through comprehensive clinical examination and optical coherence tomography analysis.

A total of 132 patients diagnosed with epiretinal membrane were enrolled in the study. The age of participants ranged from 55 to 82 years, with a mean age of 67.4 years. Inclusion criteria consisted of confirmed epiretinal membrane identified through clinical examination and spectral-domain optical coherence tomography. Patients with advanced glaucoma, active uveitis, diabetic macular edema, retinal vascular occlusions, or previous vitreoretinal surgery were excluded to minimize confounding factors affecting retinal morphology and visual function.

All participants underwent complete ophthalmological assessment. Best-corrected visual acuity was measured using standardized visual acuity charts under uniform illumination conditions. Intraocular pressure was assessed by applanation tonometry. Slit-lamp biomicroscopy and dilated fundus examination were performed to evaluate anterior and posterior segment status.

Optical coherence tomography was performed using high-resolution spectral-domain devices. The imaging protocol included macular cube scans, radial scans, and high-definition line scans centered on the fovea. Quantitative parameters evaluated included central retinal thickness, macular volume, integrity of retinal layers, foveal contour alterations, retinal folds, and presence of vitreomacular traction.

Structural abnormalities were graded according to severity. Mild cases demonstrated a thin hyperreflective membrane with minimal retinal distortion. Moderate cases exhibited retinal thickening and alteration of foveal architecture. Severe cases showed pronounced tractional changes, retinal

wrinkling, ectopic inner retinal layer formation, and significant disruption of normal macular anatomy. Functional evaluation included assessment of visual acuity, metamorphopsia severity, contrast sensitivity, and subjective visual quality. Patients were followed periodically to evaluate disease progression and correlation between anatomical changes and functional impairment.

3. Results

Clinical examination demonstrated that visual disturbances represented the most common presentation among patients with epiretinal membrane. Blurred central vision was reported by the majority of participants, while metamorphopsia and image distortion were frequently observed in individuals with moderate and advanced disease stages.

Optical coherence tomography revealed characteristic structural alterations involving the vitreoretinal interface and macular region. Early-stage membranes appeared as thin hyperreflective layers along the inner retinal surface. Although visual acuity remained relatively preserved in many of these cases, subtle changes in retinal architecture were already detectable.

Progression of the membrane was associated with increasing retinal thickness and distortion of the normal foveal contour. Central retinal thickness measurements demonstrated significant elevation compared with age-matched retinal reference values. Macular thickening was accompanied by loss of the physiological foveal depression and progressive irregularity of the retinal surface.

Retinal folds and tractional changes became increasingly evident with disease severity. OCT imaging demonstrated inward displacement of retinal layers and localized areas of retinal wrinkling. In advanced cases, pronounced traction produced significant deformation of the macular architecture and disruption of normal retinal organization.

Analysis of retinal microstructure revealed abnormalities involving the inner retinal layers and, in some cases, extension toward the outer retinal structures. Disorganization of retinal layers correlated with deterioration of visual function. Patients demonstrating substantial architectural disruption experienced greater visual impairment than those with relatively preserved retinal morphology.

Functional assessment showed a clear association between anatomical changes and visual performance. Individuals with mild structural abnormalities generally maintained satisfactory visual acuity and experienced minimal symptoms. In contrast, patients with extensive retinal distortion exhibited significant reduction in visual acuity, impaired contrast sensitivity, and severe metamorphopsia.

A strong positive correlation was identified between central retinal thickness and severity of visual symptoms. Greater retinal thickening was associated with increased image distortion and decreased visual quality. Furthermore, disruption of foveal architecture demonstrated a significant relationship with reduced reading performance and impaired daily visual activities.

Longitudinal evaluation indicated that some membranes remained stable over time, whereas others demonstrated progressive tractional activity and worsening retinal distortion. OCT monitoring enabled precise detection of disease progression even when clinical symptoms changed only minimally.

4. Discussion

The present study highlights the substantial impact of epiretinal membrane on both retinal structure and visual function. The findings confirm that progressive fibrocellular proliferation along the retinal surface leads to mechanical distortion of the macula and contributes directly to visual impairment. Age-related changes within the vitreoretinal interface appear to play a central role in disease development. Posterior vitreous detachment and microscopic retinal injury facilitate cellular migration and proliferation, resulting in membrane formation. The increasing prevalence observed among older individuals supports the importance of degenerative processes in disease pathogenesis.

Optical coherence tomography proved indispensable for identifying structural abnormalities associated with epiretinal membrane. The technology provided detailed visualization of retinal architecture and allowed objective quantification of disease severity. Many early pathological changes identified by OCT were not readily apparent during routine ophthalmoscopic examination, emphasizing the value of tomographic assessment.

One of the most important observations of this study is the strong relationship between retinal morphology and functional outcome. Structural abnormalities such as retinal thickening, foveal

distortion, and tractional deformation were closely associated with reduced visual performance. These findings support the concept that anatomical evaluation should play a central role in clinical decision-making.

The variability of clinical manifestations among patients with similar anatomical findings suggests that individual retinal resilience and neural adaptation may influence functional outcomes. Nevertheless, progressive structural deterioration generally corresponded with worsening visual symptoms and decreased quality of life.

The identification of OCT biomarkers associated with disease severity may facilitate earlier recognition of patients at risk for visual decline. Parameters such as central retinal thickness, degree of retinal distortion, and integrity of retinal layers provide valuable prognostic information and may assist in determining the optimal timing of surgical intervention.

From a therapeutic perspective, careful monitoring of anatomical progression is essential. Patients with stable retinal architecture and preserved visual function may be managed conservatively, whereas progressive structural deterioration often warrants consideration of pars plana vitrectomy with membrane peeling. Early intervention in appropriately selected cases may improve functional outcomes and prevent irreversible retinal damage.

Future investigations should focus on advanced imaging biomarkers, artificial intelligence-assisted retinal analysis, and long-term evaluation of structure-function relationships. Continued refinement of diagnostic technologies will likely improve understanding of disease mechanisms and optimize patient management.

5. Conclusion

Epiretinal membrane is a significant vitreoretinal disorder capable of producing substantial structural and functional alterations within the macular region. Progressive membrane contraction results in retinal thickening, distortion of foveal architecture, tractional changes, and disruption of normal retinal organization.

Optical coherence tomography provides highly detailed assessment of these abnormalities and serves as the most effective method for evaluating disease severity and progression. The present study demonstrates a strong correlation between tomographic findings and visual function, emphasizing the importance of integrating structural and clinical assessments.

Early detection of retinal changes through OCT facilitates accurate diagnosis, individualized monitoring, and timely therapeutic intervention. Comprehensive clinical and tomographic evaluation remains essential for preserving visual function and improving long-term outcomes in patients affected by epiretinal membrane.

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