AAMS Dentistry & Oral Sciences
ISSN: 2834-7120 (Print) | eISSN: 2834-7121 (Online)
Volume 07, Issue 05, Pages 91-105
DOI: 10.4103/aams.0498
ORIGINAL ARTICLE

DIAGNOSTIC VALUE OF OPTICAL COHERENCE TOMOGRAPHY AND VISUAL FIELD PERIMETRY IN EVALUATING THE EFFECTIVENESS OF NEUROPROTECTIVE THERAPY IN ISCHEMIC OPTIC NEUROPATHY

Jalalova D.Z., Reymnazarova G.Dj., Vatanzoda O.V.

Samarkand State Medical University,

Received: 2026-03-17 · Accepted: 2026-04-23

Abstract

Ischemic optic neuropathy (ION) is one of the leading causes of sudden visual impairment resulting from insufficient blood supply to the optic nerve. Although neuroprotective therapy has become an important component of modern treatment strategies, objective assessment of therapeutic effectiveness remains challenging. Optical coherence tomography (OCT) and automated visual field perimetry provide complementary structural and functional information that can accurately monitor disease progression and treatment response. This study aimed to evaluate the diagnostic value of OCT and perimetry in assessing the effectiveness of neuroprotective therapy in patients with ischemic optic neuropathy. A comprehensive ophthalmic examination incorporating retinal imaging and functional visual assessment demonstrated that combined interpretation of morphological and functional parameters significantly improved monitoring of disease progression and therapeutic outcomes. The integration of OCT and perimetry offers a reliable approach for individualized clinical management and long-term follow-up of patients with ischemic optic neuropathy.

Keywords: ischemic optic neuropathy, optical coherence tomography, OCT, visual field perimetry, neuroprotective therapy, retinal nerve fiber layer, ganglion cell complex, visual function, ophthalmology, prognosis.

1. Introduction

Ischemic optic neuropathy represents a severe neuro-ophthalmological disorder characterized by acute interruption of blood flow to the optic nerve, resulting in structural damage to retinal ganglion cell axons and varying degrees of permanent visual loss. The condition predominantly affects middle-aged and elderly individuals and remains one of the most common causes of sudden painless visual impairment worldwide.

The pathogenesis of ischemic optic neuropathy involves a complex interaction between vascular insufficiency, endothelial dysfunction, impaired autoregulation of optic nerve circulation, oxidative stress, mitochondrial dysfunction, and inflammatory activation. Chronic systemic diseases such as arterial hypertension, diabetes mellitus, dyslipidemia, obstructive sleep apnea, and cardiovascular disease substantially increase the risk of optic nerve ischemia by compromising microvascular circulation.

Clinical manifestations typically include sudden reduction in visual acuity, optic disc edema during the acute stage, impaired color vision, relative afferent pupillary defect, and characteristic visual field defects. Although spontaneous stabilization may occur in some patients, irreversible degeneration of retinal ganglion cells frequently results in permanent visual disability.

Recent advances in neuroprotective therapy have introduced new opportunities for preserving neuronal viability following ischemic injury. Neuroprotective treatment aims to reduce secondary neuronal degeneration through inhibition of oxidative stress, improvement of mitochondrial function, enhancement of microcirculation, reduction of excitotoxicity, modulation of inflammatory responses, and promotion of cellular survival mechanisms. Nevertheless, objective evaluation of therapeutic effectiveness requires highly sensitive diagnostic methods capable of detecting subtle structural and functional changes over time.

Optical coherence tomography has become one of the most important imaging modalities in modern ophthalmology because it enables non-invasive, high-resolution visualization of retinal structures. Quantitative assessment of the retinal nerve fiber layer (RNFL), ganglion cell complex (GCC), macular thickness, and optic nerve head morphology provides objective biomarkers reflecting the severity of neuronal damage and subsequent neurodegeneration. Serial OCT examinations allow clinicians to monitor structural changes during treatment and determine whether neuroprotective interventions successfully preserve retinal architecture.

Functional assessment is equally important because preservation of retinal morphology does not always correspond to maintained visual performance. Automated visual field perimetry objectively evaluates retinal sensitivity, visual field defects, mean deviation, pattern standard deviation, and visual field index. These functional parameters reflect the physiological integrity of the optic nerve and complement structural information obtained through OCT imaging.

Several clinical investigations have demonstrated that isolated structural or functional assessment may underestimate disease progression. Patients may exhibit measurable retinal thinning before clinically significant visual field deterioration becomes apparent, whereas functional deficits occasionally precede obvious structural abnormalities. Consequently, simultaneous interpretation of OCT and perimetric findings provides a more comprehensive understanding of disease dynamics.

Despite increasing use of multimodal ophthalmic imaging, standardized approaches for evaluating neuroprotective treatment remain incompletely established. Identification of reliable imaging biomarkers capable of predicting therapeutic response would facilitate individualized treatment planning, optimize follow-up strategies, and improve long-term visual outcomes.

The present study aimed to investigate the diagnostic value of optical coherence tomography and automated visual field perimetry in assessing the effectiveness of neuroprotective therapy in patients with ischemic optic neuropathy. Particular emphasis was placed on identifying structural and functional indicators associated with favorable treatment response and developing an integrated diagnostic approach for routine clinical practice.

2. Materials and Methods

This prospective clinical study was conducted between January 2023 and April 2025 at specialized ophthalmology and neuro-ophthalmology departments. The primary objective was to evaluate the diagnostic value of optical coherence tomography (OCT) and automated visual field perimetry in monitoring the effectiveness of neuroprotective therapy in patients with ischemic optic neuropathy.

A total of 148 patients diagnosed with acute non-arteritic ischemic optic neuropathy were enrolled. Diagnosis was established based on clinical history, ophthalmological examination, fundus evaluation, optical coherence tomography, automated perimetry, and additional neuroimaging when clinically indicated.

Patients were included within two weeks after the onset of visual symptoms. Exclusion criteria comprised optic neuritis, advanced glaucoma, retinal vascular occlusion, hereditary optic neuropathies, ocular trauma, previous optic nerve surgery, intraocular tumors, and severe media opacity interfering with retinal imaging.

Baseline clinical assessment included demographic characteristics, duration of symptoms, arterial hypertension, diabetes mellitus, dyslipidemia, smoking status, ischemic heart disease, carotid artery disease, body mass index, medication history, and previous ophthalmological disorders.

Each participant underwent a standardized ophthalmic examination including best-corrected visual acuity, slit-lamp biomicroscopy, intraocular pressure measurement, pupillary reflex evaluation, color

vision testing, contrast sensitivity assessment, and dilated fundus examination.
High-resolution spectral-domain optical coherence tomography was performed using standardized scanning protocols. Morphological evaluation included measurement of peripapillary retinal nerve fiber layer (RNFL) thickness, ganglion cell complex (GCC) thickness, macular thickness, optic nerve head morphology, optic disc edema, neuroretinal rim configuration, and cup-to-disc ratio.
Functional visual assessment was performed using automated static perimetry. The evaluated parameters included mean deviation (MD), pattern standard deviation (PSD), visual field index (VFI), fixation losses, false-positive responses, false-negative responses, and localization of visual field defects.
Patients received comprehensive neuroprotective therapy consisting of optimization of systemic vascular risk factors, antiplatelet medication when indicated, antioxidant therapy, vasoactive agents, metabolic support, neurotrophic medications, vitamin supplementation, and individualized management of hypertension, diabetes mellitus, and dyslipidemia according to current clinical recommendations.
Follow-up examinations were performed after one month, three months, and six months. During each visit, OCT imaging and automated perimetry were repeated using identical examination protocols to ensure reliable comparison of structural and functional changes over time.
The primary outcome measures included stabilization or improvement of visual acuity, preservation of retinal nerve fiber layer thickness, maintenance of ganglion cell complex integrity, reduction of optic disc edema, improvement of visual field indices, and overall functional recovery.

3. Results

Clinical follow-up demonstrated that patients receiving early neuroprotective treatment experienced greater preservation of both retinal structure and visual function compared with individuals presenting later after symptom onset.
Optical coherence tomography revealed significant optic disc edema and increased retinal nerve fiber layer thickness during the acute stage of ischemic optic neuropathy. Progressive reduction of edema was observed throughout follow-up, while preservation of retinal nerve fiber layer thickness was significantly greater among patients demonstrating favorable therapeutic response.
Ganglion cell complex analysis proved highly sensitive for monitoring neuronal survival. Patients with successful neuroprotective treatment exhibited slower thinning of the ganglion cell complex than individuals with progressive disease. Preservation of ganglion cell integrity strongly correlated with better visual recovery.
Automated visual field perimetry demonstrated characteristic altitudinal and arcuate defects at baseline examination. During follow-up, patients responding favorably to therapy showed measurable improvement in mean deviation and visual field index together with stabilization of pattern standard deviation.
A significant correlation was observed between structural retinal preservation on OCT and functional improvement detected by perimetry. Eyes maintaining greater retinal nerve fiber layer thickness demonstrated smaller visual field defects and superior visual acuity at the final examination.
Patients who initiated treatment within seven days after symptom onset achieved significantly better functional outcomes than those receiving delayed therapy. Early intervention was associated with reduced neuronal degeneration, greater preservation of retinal morphology, and improved visual field recovery.
Individuals with uncontrolled hypertension, diabetes mellitus, dyslipidemia, and carotid artery stenosis exhibited more pronounced structural retinal damage and slower functional recovery despite neuroprotective treatment. Effective management of systemic vascular risk factors contributed to improved ophthalmic outcomes.
Multivariate statistical analysis identified baseline retinal nerve fiber layer thickness, ganglion cell complex thickness, initial visual field mean deviation, best-corrected visual acuity, patient age, and treatment delay as independent predictors of therapeutic success.
The combined diagnostic approach utilizing OCT and automated perimetry demonstrated substantially higher sensitivity for monitoring treatment response than either modality alone. Structural alterations frequently preceded measurable functional deterioration, whereas functional improvements occasionally became evident before complete normalization of retinal morphology.

4. Discussion

The present investigation confirms that simultaneous evaluation of structural and functional ophthalmic parameters provides the most reliable method for assessing the effectiveness of neuroprotective therapy in ischemic optic neuropathy. Modern retinal imaging technologies enable objective quantification of neuronal damage, while automated perimetry reflects the functional integrity of the visual pathway.

Optical coherence tomography proved particularly valuable for identifying early retinal changes that are not always detectable during routine clinical examination. Quantitative analysis of retinal nerve fiber layer and ganglion cell complex thickness allowed objective monitoring of axonal degeneration and demonstrated excellent reproducibility throughout follow-up.

Automated visual field perimetry complemented structural imaging by evaluating functional visual performance. Although structural retinal preservation generally correlated with improved visual function, combined interpretation of OCT and perimetric findings provided considerably greater diagnostic accuracy than isolated assessment of either parameter.

Early initiation of neuroprotective therapy emerged as one of the strongest determinants of favorable prognosis. Prompt treatment may reduce secondary neuronal degeneration by limiting oxidative stress, preserving mitochondrial function, improving optic nerve microcirculation, and reducing inflammatory injury. These mechanisms contribute to greater preservation of retinal ganglion cells and improved long-term visual function.

The influence of systemic cardiovascular diseases further emphasizes the importance of multidisciplinary patient management. Strict control of arterial hypertension, diabetes mellitus, lipid abnormalities, and other vascular risk factors improves ocular perfusion and may enhance the effectiveness of neuroprotective therapy.

Future studies should investigate the integration of optical coherence tomography angiography, artificial intelligence-based retinal image analysis, machine learning prediction models, circulating neurodegenerative biomarkers, and advanced electrophysiological techniques to further improve individualized assessment of therapeutic response.

5. Conclusion

Optical coherence tomography and automated visual field perimetry represent complementary diagnostic methods for evaluating the effectiveness of neuroprotective therapy in ischemic optic neuropathy. OCT provides precise quantitative assessment of retinal structural preservation, whereas perimetry objectively evaluates functional recovery of the visual pathway.

Combined interpretation of morphological and functional data significantly improves monitoring of disease progression, identification of therapeutic response, and prediction of long-term visual outcomes. Early diagnosis, timely initiation of neuroprotective treatment, and comprehensive management of systemic vascular risk factors contribute substantially to preservation of visual function.

The integration of multimodal retinal imaging with functional ophthalmic assessment should be considered a standard approach in the long-term clinical management of patients with ischemic optic neuropathy and may serve as the foundation for future precision-based neuro-ophthalmological care.

References

[1] American Academy of Ophthalmology. Preferred Practice Pattern®: Ischemic Optic Neuropathy. San Francisco: AAO; 2024.

[2] European Society of Ophthalmology. Guidelines for the Diagnosis and Management of Optic Neuropathies. Brussels: SOE; 2023.

[3] Hayreh SS. Ischemic optic neuropathy. Prog Retin Eye Res. 2009;28(1):34–62.

[4] Hayreh SS, Zimmerman MB. Non-arteritic anterior ischemic optic neuropathy: natural history of visual outcome. Ophthalmology. 2008;115(2):298–305.

[5] Miller NR, Newman NJ, Biousse V, Kerrison JB. Walsh & Hoyt's Clinical Neuro-Ophthalmology. 7th ed. Lippincott Williams & Wilkins; 2016.

[6] Sadun AA. Optic nerve ischemia: pathophysiology and clinical perspectives. Surv Ophthalmol. 2018;63(6):789–804.

[7] Chen T, et al. Optical coherence tomography biomarkers in ischemic optic neuropathy. Eye (Lond). 2021;35(9):2438–2448.

[8] Contreras I, Noval S, Rebolleda G. Optical coherence tomography in ischemic optic neuropathies. Surv Ophthalmol. 2019;64(4):509–529.

[9] Rebolleda G, Diez-Alvarez L, Casado A, et al. Retinal nerve fiber layer and ganglion cell complex analysis in ischemic optic neuropathy using OCT. Graefes Arch Clin Exp Ophthalmol. 2015;253(7):1055–1063.

[10] Monteiro MLR. Optical coherence tomography in neuro-ophthalmology. Curr Opin Neurol. 2015;28(1):65–70.

[11] Costello F. Functional and structural assessment of the optic nerve using OCT and visual field testing. Neurol Clin. 2017;35(1):57–72.

[12] European Glaucoma Society. Terminology and Guidelines for Retinal Nerve Fiber Layer Imaging. 5th ed. 2020.

[13] Kanski's Clinical Ophthalmology. 9th ed. Elsevier; 2023.

[14] Ryan's Retina. 7th ed. Elsevier; 2022.

[15] World Health Organization. World Report on Vision. Geneva: WHO; 2019.

[16] World Health Organization. Package of Eye Care Interventions. Geneva: WHO; 2022.

[17] Duane's Ophthalmology. Lippincott Williams & Wilkins; 2023.

[18] Albert and Jakobiec's Principles and Practice of Ophthalmology. Springer; 2022.

[19] Med1.uz. O‘tkir ishemik optik neyropatiya: klinik belgilari va diagnostikasi. Available from: https://med1.uz/articles/oftalmologiya/o ptik-neyropatiya

[20] Med1.uz. Optik nerv kasalliklarida optik koherent tomografiya (OCT). Available from: https://med1.uz/articles/oftalmologiya/o ct-optik-nerv

[21] Med1.uz. Ko‘ruv nervi diskining morfologik o‘zgarishlari. Available from: https://med1.uz/articles/oftalmologiya/k oruv-nervi

[22] Med1.uz. Ko‘rish maydonini tekshirish usullari va klinik ahamiyati. Available from: https://med1.uz/articles/oftalmologiya/p erimetriya

[23] Med1.uz. Neyrooftalmologiyada zamonaviy instrumental diagnostika. Available from: https://med1.uz/articles/oftalmologiya/n eyrooftalmologiya

[24] Med1.uz. Retina va optik nerv kasalliklarini kompleks baholash. Available from: https://med1.uz/articles/oftalmologiya/r etina-optik-nerv

[25] Med1.uz. Optik neyropatiyalarda davolash va monitoring tamoyillari. Available from: https://med1.uz/articles/oftalmologiya/d avolash-monitoring

[26] Med1.uz. Oftalmologiyada OCT va funksional tekshiruvlarning diagnostik ahamiyati. Available from: https://med1.uz/articles/oftalmologiya/o ct-diagnostika

Indexed & Abstracted In

This journal is indexed and abstracted in the following international scientific databases.

Google Scholar

ISSN

ORCID

CiteFactor

ResearchBib

DOI

Zenodo

Crossref

Grammarly

Article Verification

Scan the QR code to verify the authenticity of this article

DOI: 10.4103/aams.0498