AAMS Laboratory Medicine & Diagnostics
ISSN: 2834-7160 (Print) | eISSN: 2834-7161 (Online)
Volume 02, Issue 05, Pages 1-15
DOI: 10.4103/aams.0498
ORIGINAL ARTICLE

MORPHOMETRIC CHANGES OF THE OPTIC DISC AND RETINAL NERVE FIBER LAYER IN ACUTE ISCHEMIC OPTIC NEUROPATHY

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

Samarkand State Medical University

Received: 2026-02-28 · Accepted: 2026-04-30

Abstract

Acute ischemic optic neuropathy is a severe vascular-neurodegenerative disorder characterized by sudden impairment of optic nerve circulation leading to structural and functional damage of visual pathways. Morphometric evaluation of the optic disc and retinal nerve fiber layer plays a crucial role in assessment of disease severity, progression of neuronal degeneration, and prediction of visual prognosis. This study investigates morphometric changes of the optic disc and retinal nerve fiber layer in patients with acute ischemic optic neuropathy using modern ophthalmological imaging technologies. Particular attention is focused on optic disc edema, retinal nerve fiber layer thickness alterations, structural remodeling of optic nerve tissue, microvascular disturbances, and correlation between morphometric abnormalities and visual dysfunction. The findings demonstrate that severity of ischemic injury significantly influences structural degeneration of retinal nerve fibers and progression of optic nerve atrophy. Early identification of morphometric alterations using optical coherence tomography contributes substantially to timely diagnosis, monitoring of disease progression, and optimization of neuroprotective therapeutic strategies. Acute ischemic optic neuropathy is a severe vascular-neurodegenerative disorder characterized by sudden impairment of optic nerve blood supply leading to progressive structural and functional damage of visual pathways. Morphometric alterations of the optic disc and retinal nerve fiber layer represent important indicators of severity of ischemic injury and progression of neuronal degeneration. This study presents an expanded analysis of morphometric changes occurring in the optic disc and retinal nerve fiber layer during acute ischemic optic neuropathy with particular attention to optic disc edema, retinal nerve fiber layer remodeling, ganglion cell degeneration, microcirculatory disturbances, and correlation between structural abnormalities and visual dysfunction. The findings demonstrate that severity of ischemic damage significantly influences degree of morphometric alteration, progression of optic nerve atrophy, and long-term visual prognosis. Early detection of structural retinal abnormalities using advanced ophthalmological imaging technologies contributes substantially to timely diagnosis, therapeutic monitoring, and preservation of residual visual function in patients with ischemic optic nerve injury.

Keywords: Acute ischemic optic neuropathy, optic disc, retinal nerve fiber layer, morphometric changes, optical coherence tomography, optic nerve edema, neurodegeneration, retinal imaging, optic atrophy, ischemic injury

1. Introduction

Acute ischemic optic neuropathy represents one of the most severe vascular disorders of the optic nerve and is associated with rapid visual deterioration resulting from impaired perfusion of optic nerve structures. The disease develops due to acute insufficiency of blood supply within posterior ciliary arteries and microvascular networks supplying the optic nerve head and retinal ganglion cell axons. Ischemic injury initiates complex pathological mechanisms including hypoxia, oxidative stress, mitochondrial dysfunction, inflammatory activation, axonal transport disruption, and progressive neuronal degeneration. Structural damage of optic nerve fibers leads to characteristic morphometric alterations involving optic disc edema, swelling of retinal nerve fiber layers, and subsequent development of optic atrophy during chronic stages of disease progression. Evaluation of morphometric changes has become increasingly important in modern neuro-ophthalmology because structural retinal alterations closely correlate with severity of visual dysfunction and long-term clinical prognosis. Optical coherence tomography currently represents one of the most informative noninvasive diagnostic technologies for quantitative assessment of retinal nerve fiber layer thickness, optic disc morphology, ganglion cell complex integrity, and structural remodeling associated with ischemic optic neuropathy. Acute stages of ischemic injury are characterized by edema and thickening of retinal nerve fiber layers resulting from axoplasmic transport disruption and intracellular fluid accumulation. Progressive neuronal degeneration subsequently leads to thinning of retinal nerve fiber structures and irreversible optic nerve atrophy associated with permanent visual impairment. Systemic vascular disorders including arterial hypertension, diabetes mellitus, dyslipidemia, atherosclerosis, and cardiovascular disease significantly contribute to severity of ischemic optic nerve injury and progression of morphometric abnormalities. Comprehensive structural evaluation of optic nerve changes therefore plays a crucial role in early diagnosis, monitoring of disease dynamics, therapeutic planning, and prediction of visual recovery outcomes in patients with acute ischemic optic neuropathy. Acute ischemic optic neuropathy represents one of the most serious vascular disorders affecting the optic nerve and remains an important cause of sudden irreversible visual impairment worldwide. The disease develops as a consequence of acute insufficiency of blood circulation within vascular networks supplying the optic nerve head and retinal ganglion cell axons. Impaired tissue perfusion initiates complex pathological mechanisms including neuronal hypoxia, oxidative stress, mitochondrial dysfunction, inflammatory activation, disruption of axoplasmic transport, intracellular edema, and progressive degeneration of optic nerve fibers. Structural remodeling of the optic disc and retinal nerve fiber layer occurs rapidly during ischemic injury and reflects severity of neuronal damage and functional visual impairment. Acute stages are characterized by optic disc swelling and thickening of retinal nerve fiber layers caused by axonal edema and accumulation of intracellular fluid secondary to ischemic disruption of axonal transport mechanisms. Progressive degeneration of retinal ganglion cell axons subsequently results in thinning of retinal nerve fiber structures and development of optic atrophy associated with permanent visual loss. Systemic vascular disorders including arterial hypertension, diabetes mellitus, dyslipidemia, ischemic heart disease, atherosclerosis, and endothelial dysfunction significantly contribute to progression of ischemic optic nerve injury and aggravation of morphometric abnormalities. Contemporary neuro-ophthalmology increasingly relies on modern imaging technologies for quantitative evaluation of structural retinal changes and objective assessment of disease progression. Optical coherence tomography provides highly informative noninvasive analysis of retinal nerve fiber layer thickness, ganglion cell complex integrity, optic disc morphology, and structural remodeling associated with ischemic optic neuropathy. Morphometric assessment has become critically important not only for early diagnosis but also for prediction of clinical prognosis, monitoring of therapeutic effectiveness, and identification of irreversible neurodegenerative changes. Comprehensive evaluation of optic disc and retinal nerve fiber alterations therefore plays a major role in optimization of individualized treatment strategies and preservation of visual function in patients with acute ischemic optic neuropathy.

2. Materials and Methods

This study was conducted using retrospective and prospective clinical analysis of patients diagnosed with acute ischemic optic neuropathy between 2020 and 2025. All patients underwent comprehensive ophthalmological examination aimed at evaluating morphometric changes of the optic disc and retinal nerve fiber layer. Clinical assessment included analysis of medical history, systemic vascular risk

factors, visual acuity, color perception, pupillary reflexes, and visual field defects. Ophthalmological investigations included fundus examination, optical coherence tomography, fluorescein angiography, computerized perimetry, retinal nerve fiber layer thickness analysis, ganglion cell complex assessment, and electrophysiological evaluation using visual evoked potentials. Morphometric parameters of the optic disc including disc area, cup-to-disc ratio, edema severity, and peripapillary retinal nerve fiber layer thickness were quantitatively analyzed and compared according to severity of ischemic injury. Doppler ultrasonography of orbital and carotid vessels was additionally performed to assess vascular hemodynamics and microcirculatory disturbances. Patients received vascular therapy, neuroprotective treatment, metabolic correction, antihypertensive management, and rehabilitation strategies aimed at preserving visual function. Statistical analysis was performed to evaluate relationships between morphometric abnormalities, degree of ischemic damage, visual dysfunction, and clinical prognosis.

3. Results

Clinical and morphometric analysis demonstrated significant structural alterations of the optic disc and retinal nerve fiber layer in patients with acute ischemic optic neuropathy. During acute stages of the disease, optical coherence tomography revealed pronounced thickening of peripapillary retinal nerve fiber layers associated with optic disc edema and axonal swelling caused by ischemic injury and disruption of axoplasmic transport. Patients with mild ischemic involvement demonstrated moderate retinal nerve fiber layer thickening with localized optic disc edema and relatively preserved ganglion cell complex structure. Moderate ischemic damage was associated with diffuse swelling of optic nerve fibers, significant increase in retinal nerve fiber layer thickness, impaired microvascular perfusion, and progressive reduction of visual acuity and visual field sensitivity. Severe ischemic optic neuropathy demonstrated marked optic disc edema, substantial structural disorganization of retinal layers, extensive electrophysiological abnormalities, and subsequent rapid thinning of retinal nerve fiber structures during chronic stages due to irreversible axonal degeneration and optic atrophy. Fluorescein angiography identified delayed optic disc filling and significant microcirculatory impairment proportional to severity of morphometric abnormalities. Patients with diabetes mellitus, arterial hypertension, and systemic atherosclerotic disease exhibited more pronounced retinal nerve fiber degeneration and poorer visual prognosis compared with individuals without major vascular pathology. Follow-up optical coherence tomography demonstrated progressive thinning of retinal nerve fiber layers and ganglion cell complex reduction during later stages of disease progression, reflecting chronic neurodegenerative remodeling of optic nerve tissue. Clinical and morphometric evaluation demonstrated significant structural abnormalities of the optic disc and retinal nerve fiber layer in patients with acute ischemic optic neuropathy. Optical coherence tomography performed during acute stages revealed pronounced thickening of peripapillary retinal nerve fiber layers associated with optic disc edema and disruption of axonal transport mechanisms. Patients with mild ischemic involvement demonstrated moderate swelling of optic nerve fibers, localized retinal thickening, and relatively preserved ganglion cell complex structure accompanied by moderate visual dysfunction. Moderate ischemic injury was associated with diffuse retinal nerve fiber layer edema, significant enlargement of optic disc structures, impaired retinal microcirculation, reduction of visual acuity, and progressive visual field constriction. Severe ischemic optic neuropathy demonstrated marked optic disc swelling, extensive structural disorganization of retinal layers, severe electrophysiological abnormalities, and substantial reduction of retinal nerve fiber layer integrity during chronic stages due to irreversible axonal degeneration. Follow-up morphometric analysis identified progressive thinning of retinal nerve fiber structures and ganglion cell complex loss reflecting chronic neurodegenerative remodeling and development of optic atrophy. Fluorescein angiography revealed delayed optic disc perfusion and pronounced microvascular circulation disturbances proportional to severity of structural abnormalities. Patients with systemic vascular pathology including diabetes mellitus, arterial hypertension, and atherosclerotic disease exhibited more severe retinal degeneration and poorer functional visual prognosis compared with individuals without significant vascular comorbidity. Early therapeutic intervention contributed to stabilization of morphometric parameters and partial preservation of retinal nerve fiber integrity in patients with mild and moderate ischemic injury, whereas advanced ischemic damage demonstrated limited structural recovery potential.

4. Discussion

The findings confirm that acute ischemic optic neuropathy is associated with significant morphometric alterations of the optic disc and retinal nerve fiber layer reflecting severity of ischemic neuronal injury and progression of neurodegenerative processes. Acute circulatory insufficiency initiates complex pathological mechanisms involving hypoxia, mitochondrial dysfunction, oxidative stress, inflammatory activation, intracellular edema, and disruption of axonal transport. These processes result in characteristic structural changes identifiable through modern ophthalmological imaging technologies. Retinal nerve fiber layer thickening observed during acute stages reflects axonal swelling and intracellular fluid accumulation secondary to ischemic injury, whereas progressive thinning during chronic stages indicates irreversible neuronal degeneration and optic nerve atrophy. The study demonstrates strong correlations between morphometric abnormalities and severity of functional visual impairment, emphasizing the diagnostic and prognostic importance of structural retinal assessment. Optical coherence tomography provides highly informative quantitative evaluation of retinal nerve fiber integrity and allows early identification of subclinical structural changes before development of advanced optic atrophy. Systemic vascular disorders substantially aggravate microcirculatory dysfunction and contribute to progression of retinal nerve fiber degeneration and chronic ischemic remodeling. Early diagnosis and timely therapeutic intervention aimed at improving vascular perfusion and reducing oxidative stress may contribute to preservation of viable neuronal tissue and stabilization of morphometric changes. Contemporary neuro-ophthalmological management increasingly emphasizes multidisciplinary cooperation involving ophthalmologists, neurologists, cardiologists, and vascular specialists to optimize diagnostic assessment and therapeutic outcomes in patients with ischemic optic neuropathy. The findings confirm that acute ischemic optic neuropathy is associated with profound morphometric remodeling of the optic disc and retinal nerve fiber layer reflecting severity of ischemic neuronal injury and progression of neurodegenerative processes. Acute interruption of optic nerve perfusion initiates a complex cascade of pathological events involving hypoxia, mitochondrial dysfunction, oxidative stress, inflammatory activation, disruption of intracellular metabolism, and progressive axonal degeneration. Retinal nerve fiber layer edema observed during acute stages reflects intracellular swelling secondary to impaired axoplasmic transport and accumulation of metabolic products within damaged neuronal structures. Progressive thinning of retinal nerve fiber layers during later stages indicates irreversible degeneration of retinal ganglion cell axons and development of optic nerve atrophy associated with severe visual dysfunction. The study demonstrates strong correlations between morphometric abnormalities and severity of visual impairment, emphasizing the clinical importance of quantitative structural retinal assessment. Optical coherence tomography represents one of the most valuable diagnostic technologies for early identification of ischemic retinal remodeling and objective monitoring of disease progression. Systemic vascular disorders substantially aggravate microcirculatory insufficiency and accelerate neurodegenerative remodeling of optic nerve tissue. Chronic hypertension, diabetes mellitus, endothelial dysfunction, and atherosclerosis impair autoregulation of optic nerve blood flow and increase susceptibility to severe ischemic injury. Early comprehensive ophthalmological evaluation and timely neuroprotective intervention may contribute to preservation of viable neuronal tissue and reduction of irreversible structural degeneration. Modern neuro-ophthalmological management increasingly emphasizes multidisciplinary approaches involving ophthalmologists, neurologists, cardiologists, endocrinologists, and vascular specialists to optimize therapeutic outcomes and minimize progression of permanent visual disability in patients with ischemic optic neuropathy.

5. Conclusion

Acute ischemic optic neuropathy is associated with significant morphometric changes of the optic disc and retinal nerve fiber layer reflecting severity of ischemic injury and progression of neurodegenerative remodeling. Optical coherence tomography provides valuable quantitative assessment of structural retinal abnormalities and plays a central role in diagnosis, monitoring, and prognosis of ischemic optic nerve damage. Acute stages are characterized by optic disc edema and retinal nerve fiber layer thickening, whereas chronic progression leads to irreversible thinning and optic atrophy associated with severe visual dysfunction. Early comprehensive morphometric evaluation and timely neuroprotective intervention contribute substantially to preservation of residual visual function and reduction of irreversible neuronal degeneration. Individualized multidisciplinary

management remains essential for improving long-term outcomes in patients with acute ischemic optic neuropathy. Acute ischemic optic neuropathy is associated with significant morphometric changes of the optic disc and retinal nerve fiber layer reflecting severity of ischemic injury and progression of neurodegenerative remodeling. Acute stages are characterized by optic disc edema and retinal nerve fiber layer thickening, whereas chronic progression leads to thinning of retinal structures and irreversible optic atrophy associated with severe visual impairment. Optical coherence tomography provides highly informative quantitative assessment of structural retinal abnormalities and plays a central role in diagnosis, monitoring, and prognosis of ischemic optic nerve disorders. Early identification of morphometric alterations and comprehensive neuroprotective management contribute substantially to preservation of residual visual function and reduction of irreversible neuronal degeneration. Individualized multidisciplinary therapeutic strategies remain essential for improving long-term visual outcomes in patients with acute ischemic optic neuropathy.

References

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

[2] Contreras I, Noval S, Rebolleda G, Muñoz-Negrete FJ. Follow-up of nonarteritic anterior ischemic optic neuropathy with optical coherence tomography. Ophthalmology. 2007;114(12):2338–2344.

[3] Rebolleda G, Diez-Alvarez L, Casado A, et al. OCT: new perspectives in neuro-ophthalmology. Saudi J Ophthalmol. 2015;29(1):9–25.

[4] Danesh-Meyer HV, Boland MV, Savino PJ, et al. Optic disc morphology in ischemic optic neuropathy. Br J Ophthalmol. 2001;85(4):437–441.

[5] Arnold AC. Pathogenesis of nonarteritic anterior ischemic optic neuropathy. J Neuroophthalmol. 2003;23(2):157–163.

[6] Savini G, Carbonelli M, Barboni P. Retinal nerve fiber layer evaluation by optical coherence tomography in optic neuropathies. Ophthalmology. 2006;113(1):125–130.

[7] Kupersmith MJ, Garvin M, Wang JK, et al. Retinal ganglion cell layer thinning in optic neuropathy. Am J Ophthalmol. 2011;152(6):1058–1066.

[8] Biousse V, Newman NJ. Ischemic optic neuropathies. N Engl J Med. 2015;372(25):2428–2436.

[9] Hood DC, Kardon RH. A framework for comparing structural and functional measures in glaucoma and optic neuropathies. Prog Retin Eye Res. 2007;26(6):688–710.

[10] Costello F, Coupland S, Hodge W, et al. Quantifying axonal loss after optic neuritis with optical coherence tomography. Ann Neurol. 2006;59(6):963–969.

[11] Bellusci C, Savini G, Carbonelli M, et al. Retinal nerve fiber layer thickness in nonarteritic anterior ischemic optic neuropathy. Eur J Ophthalmol. 2008;18(6):986–992.

[12] Kardon R. Optical coherence tomography in optic neuritis and ischemic optic neuropathy. Neuroimaging Clin N Am. 2005;15(3):593–604.

[13] Lee EJ, Kim TW, Kim JA, et al. Clinical implications of optic nerve head morphology in ischemic optic neuropathy. Invest Ophthalmol Vis Sci. 2010;51(12):6704–6709.

[14] Moura FC, Medeiros FA, Zangwill LM, et al. Diagnostic ability of optical coherence tomography in neuro-ophthalmic diseases. Ophthalmology. 2007;114(6):1141–1148.

[15] Levin LA, Nilsson SFE, Ver Hoeve J, et al. Adler's Physiology of the Eye. 11th ed. Elsevier; 2011.

[16] Wilhelm H, Schabet M. Diagnosis and treatment of optic neuropathies. Dtsch Arztebl Int. 2015;112(37):616–626.

[17] Hayreh SS, Zimmerman MB. Nonarteritic anterior ischemic optic neuropathy: natural history and visual outcome. Ophthalmology. 2008;115(2):298–305.

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

[19] Med1.uz. Морфометрия диска зрительного нерва при офтальмологических заболеваниях. Available from: https://med1.uz/articles/oftalmologiya/m orfometriya

[20] Med1.uz. Оптическая когерентная томография в диагностике нейроофтальмологических заболеваний. Available from: https://med1.uz/articles/oftalmologiya/o kt-neirooftalmologiya

[21] Med1.uz. Слой нервных волокон сетчатки и его клиническое значение. Available from: https://med1.uz/articles/oftalmologiya/n ervnye-volokna

[22] Med1.uz. Ишемическая оптическая нейропатия: диагностика и лечение. Available from: https://med1.uz/articles/oftalmologiya/i shemicheskaya-neiropatiya

[23] Med1.uz. Современные методы визуализации зрительного нерва. Available from: https://med1.uz/articles/diagnostika/viz ualizatsiya

[24] Med1.uz. Изменения сетчатки при сосудистых заболеваниях глаза. Available from: https://med1.uz/articles/oftalmologiya/s etchatka

[25] Med1.uz. Нейродегенеративные изменения зрительного анализатора. Available from: https://med1.uz/articles/nevrologiya/nei rodegeneratsiya

[26] Med1.uz. Современные подходы к диагностике заболеваний зрительного нерва. Available from: https://med1.uz/articles/oftalmologiya/d iagnostika-zritelnogo-nerva

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