OPTICAL COHERENCE TOMOGRAPHY IN DIAGNOSTICS OF OPTIC NERVE PATHOLOGY

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Abstract. *Optical coherence tomography (OCT) has revolutionized the diagnostic capabilities of modern ophthalmology, especially in assessing optic nerve pathologies. Its non-invasive, high-resolution imaging allows detailed visualization of the retinal nerve fiber layer, optic nerve head, and ganglion cell complex. This article explores the comprehensive role of OCT in the diagnosis, follow-up, and evaluation of diseases affecting the optic nerve. OCT has proven valuable in identifying early signs of optic nerve damage in glaucoma, optic neuritis, and other neuro-ophthalmic disorders. The review presents clinical implications of OCT findings, discusses its advantages and limitations, and underscores the importance of its integration into routine clinical practice. Optical coherence tomography (OCT) is an innovative, non-invasive imaging technique that provides high-resolution cross-sectional views of the retina and optic nerve. Its application in the diagnosis of optic nerve pathologies has significantly improved early detection, monitoring, and management of various neuro-ophthalmic disorders. This article explores the diagnostic value of OCT in diseases such as glaucoma, optic neuritis, ischemic optic neuropathy, and hereditary optic neuropathies. The precision of OCT in visualizing retinal nerve fiber layer (RNFL) thinning, optic disc changes, and ganglion cell loss allows clinicians to detect subclinical pathology and monitor progression before irreversible vision loss occurs. By enabling earlier intervention and objective evaluation of therapeutic response, OCT has become indispensable in modern ophthalmologic practice. The article emphasizes the technological advancements, clinical implications, and future potential of OCT as a cornerstone tool in the evaluation of optic nerve disorders.*

Keywords: *Optical coherence tomography, optic nerve, glaucoma, optic neuritis, retinal nerve fiber layer, neuro-ophthalmology, ophthalmic diagnostics, OCT imaging.*

Introduction

The optic nerve plays a central role in vision, serving as the conduit for transmitting visual information from the retina to the brain. Diseases that affect the optic nerve can lead to partial or

complete vision loss, and early diagnosis is crucial to prevent irreversible damage. Optical coherence tomography (OCT) provides a rapid, non-invasive means of obtaining high-resolution cross-sectional images of ocular tissues.

The optic nerve is a critical component of the visual system, transmitting signals from the retina to the brain for visual perception. Damage to this structure, whether due to increased intraocular pressure, ischemic events, inflammatory processes, or hereditary conditions, can result in permanent visual impairment. Traditional diagnostic methods such as visual field testing and fundoscopy, while useful, often detect damage only after significant functional loss has occurred.

Optical coherence tomography (OCT), since its introduction in the 1990s, has transformed the landscape of ocular diagnostics. With axial resolutions approaching 5 microns in modern spectral-domain systems, OCT enables clinicians to visualize and measure microstructural changes in the retina and optic nerve head with remarkable accuracy. It provides objective, quantifiable data on the thickness of the retinal nerve fiber layer, the morphology of the optic disc, and the integrity of the ganglion cell complex-all of which are vital in assessing the health of the optic nerve.

In recent years, OCT has gained prominence not only in glaucoma diagnosis but also in evaluating a broad range of optic neuropathies, including optic neuritis associated with multiple sclerosis, anterior ischemic optic neuropathy, and hereditary conditions such as Leber’s hereditary optic neuropathy. Furthermore, OCT aids in differentiating true papilledema from pseudopapilledema, a distinction critical in neuro-ophthalmologic evaluations.

The objective of this study is to evaluate the diagnostic efficacy of OCT in a variety of optic nerve pathologies encountered in clinical practice. Through a detailed analysis of clinical cases and imaging findings, we aim to demonstrate how OCT can enhance diagnostic precision, inform treatment decisions, and serve as a reliable tool for longitudinal monitoring. Since its introduction in the 1990s, OCT has advanced significantly, now allowing for detailed imaging of the optic nerve head (ONH), peripapillary retina, and macular ganglion cell layers. These capabilities have made OCT a vital tool in neuro-ophthalmology for both initial diagnosis and longitudinal monitoring of optic nerve diseases.

Materials and Methods

This study is based on a retrospective analysis of patient data collected from the Department of Ophthalmology at Samarkand State Medical University. The focus was on patients who presented with symptoms indicative of optic nerve pathology between 2021 and 2024. All patients underwent comprehensive ophthalmological examinations, including best-corrected

visual acuity, intraocular pressure measurement, fundus examination, visual field testing, and OCT imaging. OCT scans were acquired using spectral-domain devices with standard protocols for RNFL, macular, and ONH analysis. Data were evaluated for changes in retinal nerve fiber layer thickness, optic disc morphology, and presence of edema, atrophy, or cupping.

Results

OCT imaging allowed clear identification of pathologic changes in the optic nerve in a majority of patients. In glaucoma cases, significant thinning of the RNFL was observed, particularly in the superior and inferior quadrants. Patients with optic neuritis demonstrated acute RNFL swelling, followed by thinning upon chronic follow-up. Cases of non-arteritic anterior ischemic optic neuropathy (NAION) revealed segmental RNFL loss, typically associated with altitudinal visual field defects. OCT also helped differentiate between papilledema and pseudopapilledema by evaluating subtle differences in disc elevation and peripapillary retinal changes. In hereditary optic neuropathies, OCT showed diffuse RNFL thinning, providing insight into the progression and helping guide genetic testing.

Discussion

The utility of OCT in optic nerve diagnostics cannot be overstated. It offers real-time, objective assessment of neural tissue and helps guide treatment decisions. For instance, identifying RNFL thinning before visual field loss in glaucoma allows earlier intervention and better prognosis. Similarly, the ability to track RNFL thickness over time aids in assessing the response to therapy in optic neuritis and multiple sclerosis. OCT's high reproducibility also makes it ideal for long-term monitoring of chronic optic nerve conditions. Despite its many strengths, limitations exist, including image quality dependence on patient cooperation, challenges in interpreting images in advanced atrophy, and cost considerations. Future directions involve the integration of OCT angiography and artificial intelligence-based analysis, which may allow even earlier and more precise detection of optic nerve disorders.

Conclusion

OCT has become an indispensable tool in the modern ophthalmologist's arsenal, particularly in diagnosing and managing optic nerve diseases. Its ability to visualize microscopic changes in the retina and optic nerve head structure enhances clinical decision-making and improves patient outcomes. Continued advancements in OCT technology and broader access to its use are likely to further its impact in the coming years. Incorporating OCT into routine practice is strongly recommended for any comprehensive ophthalmologic evaluation.

Optical coherence tomography has become an integral part of the diagnostic algorithm in ophthalmology, particularly in the evaluation of optic nerve pathologies. Its ability to provide detailed, reproducible images of the retinal nerve fiber layer and optic disc structure makes it an invaluable tool for both early diagnosis and long-term monitoring. The findings from our clinical analysis confirm that OCT is effective in detecting subtle changes in the optic nerve that are often not visible through traditional examination techniques. In diseases such as glaucoma, early RNFL thinning can be identified before visual field loss is detectable, allowing for timely therapeutic intervention. Similarly, OCT plays a crucial role in monitoring the course of inflammatory and ischemic optic neuropathies, helping assess disease progression and response to treatment.

Moreover, the ability of OCT to distinguish between papilledema and pseudopapilledema enhances diagnostic accuracy in neuro-ophthalmologic settings and reduces unnecessary neurological investigations. While limitations exist, such as image artifacts and patient compliance challenges, ongoing technological advancements continue to enhance its reliability and accessibility.

In conclusion, OCT should be considered a standard imaging modality in the evaluation of optic nerve diseases. Its incorporation into routine clinical practice not only improves diagnostic confidence but also enhances patient outcomes through earlier intervention and more personalized treatment strategies.

References