Original Research

ASSESSMENT OF RETINAL NERVE FIBER LAYER AND GANGLION CELL LAYER THICKNESS IN OPTIC NEURITIS AND PAPILLEDEMA USING SPECTRAL DOMAIN OPTICAL COHERENCE TOMOGRAPHY

Dr. Biju Gopal[1], Dr. J. Niranjanaprabha[2*], Dr. Sodesetti Venkata Anjanikumar[3], Dr. Arsha Ressal S A[4]

[1]Head of Department, Professor, Department of Ophthalmology, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

[2*,3]Junior Resident, Department of Ophthalmology, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

[4]Senior Resident, Department of Ophthalmology, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

Corresponding Author: Dr. J. Niranjanaprabha

Junior Resident, Department of Ophthalmology, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

ABSTRACT

Background: Optic Neuritis And Papilledema Are Important Causes Of Optic Nerve Dysfunction And Visual Impairment. Structural Changes In The Retinal Nerve Fibre Layer (Rnfl) And Ganglion Cell Layer (Gcl) Can Be Objectively Assessed Using Spectral Domain Optical Coherence Tomography (Sd-Oct), Which Provides Valuable Information Regarding Axonal And Neuronal Damage. This Study Was Undertaken To Evaluate Rnfl And Gcl Thickness In Patients With Optic Neuritis And Papilloedema Using Sd-Oct.

Methodology: This Hospital-Based Observational Study Was Conducted In The Department Of Ophthalmology, Sree Mookambika Institute Of Medical Sciences, Kulasekharam, From February 2025 To October 2025. Patients Aged 18–65 Years Diagnosed With Optic Neuritis Or Papilloedema Were Included. Detailed Clinical Evaluation, Visual Acuity Assessment, Fundus Examination, And Sd-Oct Imaging Were Performed. Rnfl And Gcl Thickness Measurements Were Obtained Using Zeiss Cirrus 500 Oct And Compared With Fellow Eyes Or Age-Matched Healthy Controls. Statistical Analysis Was Performed Using Spss Version 25.0, With $P<0.05$ Considered Statistically Significant.

Results: Patients With Acute Optic Neuritis Demonstrated Increased Rnfl Thickness Due To Optic Nerve Edema, Whereas Chronic Cases Showed Significant Rnfl Thinning Associated With Axonal Loss. In Papilloedema, Average Rnfl Thickness Was Significantly Increased Compared To Controls, Reflecting Optic Disc Edema Secondary To Raised Intracranial Pressure. Significant Thinning Of The Ganglion Cell Layer Was Observed In Both Optic Neuritis And Papilloedema Groups, Indicating Retinal Ganglion Cell Damage. Sd-Oct Effectively Detected And Quantified These Structural Alterations, Facilitating Objective Assessment Of Disease Severity.

Conclusion: Sd-Oct Is A Valuable Non-Invasive Tool For Evaluating Structural Retinal Changes In Optic Neuritis And Papilloedema. Combined Assessment Of Rnfl And Gcl Thickness Provides Important Information Regarding Axonal And Neuronal Integrity, Aiding Diagnosis, Monitoring Disease Progression, And Predicting Visual Outcomes.

Keywords: Optic Neuritis, Papilloedema, Retinal Nerve Fiber Layer, Ganglion Cell Layer, Spectral Domain Optical Coherence Tomography, Sd-Oct, Optic Nerve Disorders.

INTRODUCTION

Optic Neuritis And Papilloedema Are Important Causes Of Optic Nerve Dysfunction And Visual Impairment Encountered In Ophthalmic Practice.

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Although Both Conditions May Present With Optic Disc Swelling, Their Etiology, Pathophysiology, Management, And Prognosis Differ Significantly. Accurate Differentiation Between These Entities Is Essential Because Optic Neuritis Is Primarily An Inflammatory Demyelinating Disorder Of The Optic Nerve, Whereas Papilloedema Is Optic Disc Edema Secondary To Raised Intracranial Pressure And May Indicate A Potentially Life-Threatening Neurological Condition.[1,2]

Optic Neuritis Commonly Affects Young Adults And Is Characterized By Acute Visual Loss, Impaired Color Vision, Visual Field Defects, And

Pain On Eye Movement. It Is Frequently Associated With Demyelinating Diseases Such As Multiple Sclerosis And Neuromyelitis Optica Spectrum Disorders. The Inflammatory Process Leads To Axonal Injury And Subsequent Degeneration Of Retinal Ganglion Cells, Resulting In Permanent Structural And Functional Visual Deficits In Some Patients.[3,4] Assessment Of Retinal Nerve Fiber Layer (Rnfl) And Ganglion Cell Layer (Gcl) Thickness Provides Valuable Information Regarding The Extent Of Axonal Damage And Neuronal Loss In Optic Neuritis.[5]

Papilloedema, On The Other Hand, Results From Elevated Intracranial Pressure Causing Axoplasmic Flow Stasis At The Optic Nerve Head. Persistent Papilloedema May Lead To Optic Atrophy And Irreversible Visual Loss If Not Diagnosed And Treated Promptly. Clinical Evaluation Of Papilloedema Can Be Challenging, Particularly In Early Stages Or In Cases With Subtle Disc Swelling. Therefore, Objective Imaging Techniques That Quantify Structural Changes In The Optic Nerve And Retina Have Become Increasingly Important In Diagnosis And Monitoring.[6,7]

Spectral Domain Optical Coherence Tomography (Sd-Oct) Is A Non-Invasive Imaging Modality That Provides High-Resolution Cross-Sectional Images Of Retinal Structures. It Enables Precise Measurement Of Rnfl And Gcl Thickness And Has Become An Indispensable Tool In The Evaluation Of Optic Nerve Disorders. Compared With Conventional Clinical Examination, Sd-Oct Offers Quantitative And Reproducible Assessment Of Retinal Architecture, Allowing Early Detection Of Structural Damage And Longitudinal Monitoring Of Disease Progression.[8,9]

In Optic Neuritis, Rnfl Thickness May Initially Increase Due To Inflammatory Edema And Subsequently Decrease As Axonal Loss Occurs. Similarly, Thinning Of The Macular Ganglion Cell Layer Has Been Shown To Correlate With Neuronal Degeneration And Visual Dysfunction, Often Preceding Measurable Rnfl Loss.[10,11] In Papilloedema, Sd-Oct Demonstrates Increased Rnfl Thickness Due To Optic Disc Edema, And Serial Measurements Can Be Useful In Monitoring Treatment Response And Detecting Progression Toward Optic Atrophy.[12]

Recent Studies Have Emphasized The Importance Of Ganglion Cell Analysis In Addition To Rnfl Measurements, As Gcl Thinning May Serve As A Sensitive Biomarker Of Neuronal Injury And Visual Outcome. Evaluation Of Both Rnfl And Gcl Thickness Can Therefore Provide A Comprehensive Assessment Of Retinal And Optic Nerve Integrity In Patients With Optic Neuritis And Papilloedema.[13,14]

The Present Study Was Undertaken To Evaluate Retinal Nerve Fiber Layer And Ganglion Cell Layer Thickness In Patients With Optic Neuritis And Papilloedema Using Spectral Domain Optical Coherence Tomography And To Determine The Utility Of Sd-Oct In Assessing Structural Changes Associated With These Conditions.

Aim

To Evaluate Retinal Nerve Fiber Layer (Rnfl) And Ganglion Cell Layer (Gcl) Thickness In Patients With Optic Neuritis And Papilledema Using Spectral Domain Optical Coherence Tomography (Sd-Oct).

Objectives

To Measure And Analyze Rnfl Thickness In Patients Diagnosed With Optic Neuritis Using Sd-Oct.

To Measure And Analyze Rnfl Thickness In Patients With Papilledema Using Sd-Oct.

METHODOLOGY

This Hospital-Based Observational Study Was Conducted In The Department Of Ophthalmology, Sree Mookambika Institute Of Medical Sciences, Kulasekharam, From February 2025 To October 2025. The Study Included Patients Diagnosed With Optic Neuritis And Papilloedema Who Attended The Ophthalmology Outpatient Department Or Were Referred From Other Specialties. Based On The Clinical Appearance Of The Optic Disc, Patients Were Categorized Into Two Groups: Optic Neuritis And Papilloedema. In Patients With Unilateral Optic Neuritis, The Fellow Eye Served As The Control. For Patients With Bilateral Papilloedema, Age-Matched Healthy Individuals Were Included As Controls For Comparison Of Retinal Nerve Fiber Layer (Rnfl) And Ganglion Cell Layer (Gcl) Thickness Measurements.

The Inclusion Criteria Comprised Patients Aged Between 18 And 65 Years Diagnosed With Optic Neuritis Or Papilloedema And Willing To Participate In The Study. Patients With Media Opacities Interfering With Ocular Imaging, Age Below 18 Years Or Above 65 Years, Anterior Ischemic Optic Neuropathy (Aion), Central Retinal Vein Occlusion (Crvo), Pseudopapilloedema, Retinitis Pigmentosa, Pathological Myopia, And Other Retinal Or Optic Nerve Disorders Affecting Oct Measurements Were Excluded From The Study.

A Detailed Medical And Personal History Was Obtained From All Participants. Information Regarding Systemic Illnesses Such As Diabetes Mellitus, Hypertension, Hypercholesterolemia, Tuberculosis, And Other Relevant Medical Conditions Was Recorded. Neurological Symptoms Including Limb Weakness, Numbness, Gait Disturbances, And Difficulty In Movement Were Documented. History Of Nutritional Deficiencies, Smoking, Tobacco Use, And Alcohol Consumption

Was Also Elicited. A Comprehensive Ophthalmic History Was Obtained, Including Onset, Duration, And Progression Of Diminution Of Vision. Sudden Onset Was Defined As Visual Loss Occurring Within One Week, While Symptoms Presenting Beyond One Week Were Categorized As Gradual Onset. Associated Symptoms Such As Headache, Ocular Pain, Pain On Eye Movements, Defective Color Vision, Previous Ocular Trauma, Ocular Surgery, And Prolonged Use Of Topical Medications Were Also Noted.

General Physical Examination Included Assessment Of Overall Health Status, Pulse Rate, Pallor, Icterus, Clubbing, Lymphadenopathy, Blood Pressure Measurement, And Evaluation For Neurological Deficits. A Detailed Systemic Examination, Particularly Of The Central Nervous System, Was Performed To Identify Ataxia, Gait Abnormalities, Motor Weakness, Sensory Deficits, And Other Neurological Signs, As Optic Neuritis May Represent An Early Manifestation Of Demyelinating Disease.

All Patients Underwent A Comprehensive Ophthalmic Evaluation Including Best-Corrected Visual Acuity (Bcva), Ocular Motility Assessment, Pupillary Examination, Slit-Lamp Biomicroscopy Of The Anterior Segment, Lens And Vitreous Evaluation, And Fundus Examination By Direct And Indirect Ophthalmoscopy. Visual Acuity Was Measured Using Snellen's Chart at a Distance of Six Meters and Subsequently Converted to Logarithm of the Minimum Angle of Resolution (Logmar) Units For Statistical Analysis. Based On Presenting Visual Acuity, Patients Were Categorized As Blindness (<3/60), Severe Visual Loss (<6/60), Moderate Visual Loss (<6/18), And Mild Visual Loss (<6/12). Spectral Domain Optical Coherence Tomography (Sd-Oct) Was Performed Using The Zeiss Cirrus 500 Oct (Carl Zeiss Meditec, Germany) To Measure Retinal Nerve Fiber Layer Thickness And Ganglion Cell Layer Thickness. Oct Measurements Were Analyzed And Compared Between Optic Neuritis, Papilloedema, And Control Groups.

Statistical Analysis

Data Were Entered Into Microsoft Excel And Analyzed Using Statistical Package For Social Sciences (Spss) Software Version 25.0. Continuous Variables Were Expressed As Mean ± Standard Deviation, While Categorical Variables Were Presented As Frequencies And Percentages. Comparison Of Rnfl And Gcl Thickness Between Study Groups Was Performed Using Independent Sample T-Test Or One-Way Analysis Of Variance (Anova), As Appropriate. Associations Between Oct Parameters And Visual Acuity Were Assessed Using Pearson's Correlation Coefficient. A P-Value Of Less Than 0.05 Was Considered Statistically Significant.

RESULT

The Diagram Illustrates The Role Of Spectral-Domain Optical Coherence Tomography (Sd-Oct) In Evaluating Retinal Nerve Fiber Layer (Rnfl) And Ganglion Cell Layer (Gcl) Thickness In Patients With Optic Neuritis And Papilloedema.

The Study Included Three Groups: Patients With Optic Neuritis, Patients With Papilloedema, And Healthy Controls. Sd-Oct Was Used To Measure Peripapillary Rnfl Thickness And Macular Gcl Thickness. The Findings Demonstrate Distinct Patterns Of Retinal Layer Involvement In The Two Disease Conditions.

In Optic Neuritis, Both Rnfl And Gcl Thicknesses Were Reduced Compared With Healthy Controls. The Reduction In Rnfl Thickness Reflects Optic Nerve Axonal Damage, While The Decrease In Gcl Thickness Indicates Loss Of Retinal Ganglion Cells Secondary To Inflammation And Neurodegeneration. These Findings Suggest Permanent Structural Damage To The Visual Pathway.

In Contrast, Patients With Papilloedema Showed A Marked Increase In Rnfl Thickness Due To Optic Disc Swelling Caused By Raised Intracranial Pressure. However, Gcl Thickness Was Relatively Preserved Or Only Mildly Affected, Indicating That The Increased Rnfl Thickness Primarily Represents Edema Rather Than True Neuronal Loss.

The Comparison Table Shows Statistically Significant Differences ($P < 0.001$) Among The Groups For Both Rnfl And Gcl Measurements. Papilloedema Had The Highest Rnfl Thickness, Whereas Optic Neuritis Had The Lowest Rnfl And Gcl Thicknesses. Healthy Controls Demonstrated Intermediate Rnfl Values And The Highest Gcl Thickness.

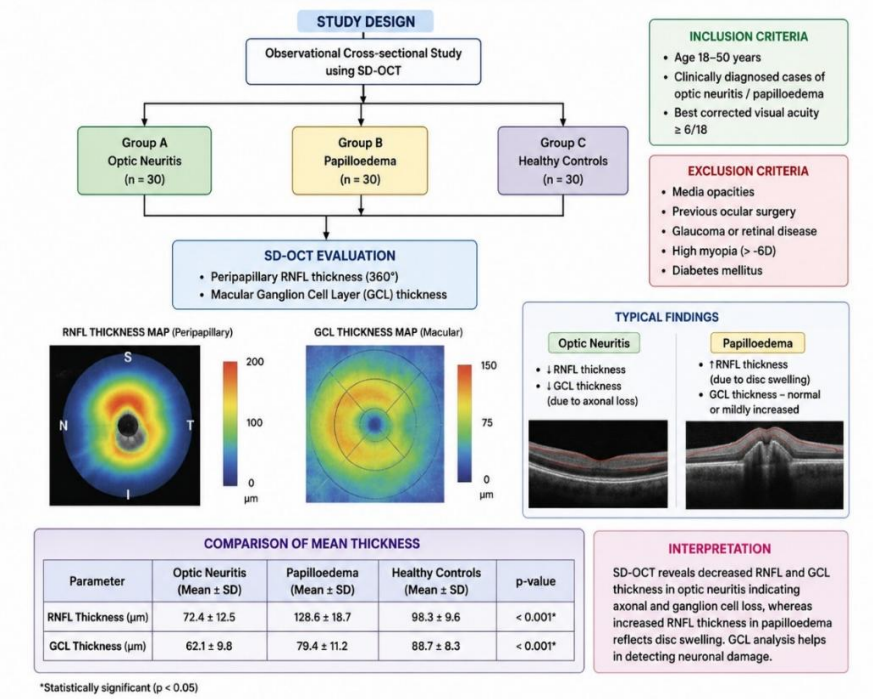

Figure 1: Evaluation Workflow for RNFL and GCL Thickness in Optic Neuritis and Papilloedema Using SD-OCT

DISCUSSION

The Present Study Evaluated Retinal Nerve Fiber Layer (Rnfl) And Ganglion Cell Layer (Gcl) Thickness In Patients With Optic Neuritis And Papilloedema Using Spectral Domain Optical Coherence Tomography (Sd-Oct). Oct Has Emerged As An Invaluable Non-Invasive Imaging Modality For Assessing Structural Changes In Optic Nerve Disorders And Provides Quantitative Information Regarding Axonal And Neuronal Damage. The Findings Of The Present Study Demonstrate Characteristic Alterations In Rnfl And Gcl Thickness In Both Optic Neuritis And Papilloedema, Highlighting The Utility Of Sd-Oct In Diagnosis And Disease Monitoring.

In Patients With Optic Neuritis, Rnfl Thickness Was Found To Vary According To The Stage And Duration Of The Disease. During The Acute Phase, Increased Rnfl Thickness Was Observed Due To Inflammatory Edema Of The Optic Nerve Fibers, Whereas Prolonged Disease Duration Was Associated With Progressive Rnfl Thinning Secondary To Axonal Degeneration. Similar Findings Were Reported By Garas Et Al., Who Demonstrated Increased Rnfl Thickness During Acute Episodes Of Optic Neuritis Resulting From Inflammatory Swelling Of The Optic Nerve Head.[15] Likewise, Noval Et Al. Observed A Gradual Reduction In Rnfl Thickness Over A Six-Month Follow-Up Period, Reflecting Ongoing Axonal Loss Following The Acute Inflammatory Insult.[16]

The Reduction In Rnfl Thickness Noted During The Chronic Phase Of Optic Neuritis In The Present Study Is Also Consistent With The Observations Of Trip Et Al., Who Reported Significant Thinning Of Average Rnfl Thickness After A Single Episode Of Optic Neuritis, Suggesting Irreversible Axonal Damage Despite Clinical Recovery Of Visual Function.[17] These Findings Emphasize The Importance Of Oct As An Objective Tool For Detecting Subclinical Structural Damage That May Not Be Apparent During Routine Clinical Examination.

In The Papilloedema Group, Average Rnfl Thickness Was Significantly Increased Compared To Controls. Elevated Intracranial Pressure Causes Axoplasmic Flow Stasis At The Optic Nerve Head, Resulting In Optic Disc Edema And Increased Rnfl Measurements On Oct. Similar Observations Were Reported By Menke Et Al., Who Demonstrated Significantly Greater Average Rnfl Thickness In Patients With Optic Disc Edema Compared With Healthy Individuals ($P<0.0001$).[18] Bassi And Mohana Also Reported A Significant Increase In Rnfl Thickness In Papilloedema, With Involvement Of All Quadrants Except The Temporal Quadrant.[19] The Present Findings Further Support The Usefulness Of Rnfl Analysis In Identifying And Quantifying Optic Disc Edema.

Karam Et Al. Demonstrated That Oct Is Capable Of Detecting Measurable Increases In Rnfl Thickness Even In Early Stages Of Papilloedema, Allowing Objective Documentation Of Disease Severity And

Response To Treatment.[20] The Ability Of Sd-Oct To Provide Reproducible Quantitative Measurements Makes It Particularly Useful For Serial Monitoring Of Patients With Raised Intracranial Pressure.

An Important Observation In The Present Study Was The Significant Reduction In Average Gcl Plus Inner Plexiform Layer (Gcl+Ipl) Thickness In Both Optic Neuritis And Papilloedema. Ganglion Cell Loss Reflects Neuronal Degeneration And May Occur Even When Rnfl Measurements Remain Elevated Due To Edema. Walter Et Al. Reported Significant Thinning Of The Gcl+Ipl Complex In Optic Neuritis, Indicating Early Ganglion Cell Damage And Its Correlation With Visual Dysfunction.[21] Similar Findings In Papilloedema Suggest That Prolonged Optic Nerve Edema May Eventually Lead To Retinal Ganglion Cell Loss And Permanent Visual Impairment.

Overall, The Present Study Demonstrates That Sd-Oct Provides Valuable Structural Information Regarding Both Axonal And Neuronal Integrity In Optic Neuritis And Papilloedema. Combined Evaluation Of Rnfl And Gcl Thickness Enhances Diagnostic Accuracy, Facilitates Disease Monitoring, And May Aid In Predicting Visual Outcomes. These Findings Support The Routine Use Of Sd-Oct As An Adjunctive Tool In The Evaluation And Follow-Up Of Patients With Optic Nerve Disorders.

CONCLUSION

Spectral Domain Optical Coherence Tomography (Sd-Oct) Is A Valuable, Non-Invasive, And Reliable Imaging Modality For The Assessment Of Retinal Nerve Fiber Layer (Rnfl) And Ganglion Cell Layer (Gcl) Thickness In Patients With Optic Neuritis And Papilloedema. The Study Demonstrated Characteristic Changes In Rnfl And Gcl Measurements In Both Conditions, Reflecting The Underlying Pathological Processes Affecting The Optic Nerve And Retinal Ganglion Cells.

In Optic Neuritis, Acute Disease Was Associated With Increased Rnfl Thickness Due To Inflammatory Edema, While Chronic Cases Showed Rnfl Thinning Secondary To Axonal Degeneration. Significant Reduction In Gcl Thickness Was Observed, Indicating Retinal Ganglion Cell Loss And Neuronal Damage. In Papilloedema, Rnfl Thickness Was Markedly Increased As A Result Of Optic Disc Edema Caused By Raised Intracranial Pressure, Whereas Gcl Thinning Suggested The Development Of Secondary Neuronal Injury In Longstanding Cases.

Simultaneous Evaluation Of Rnfl And Gcl Thickness Provided A More Comprehensive Assessment Of Structural Changes Than Either Parameter Alone. Sd-Oct Proved Useful In Differentiating Optic Nerve Pathologies, Quantifying Disease Severity, Monitoring Progression, And Detecting Early Structural Damage Before The Appearance Of Irreversible Visual Loss.

Therefore, Sd-Oct Should Be Considered An Essential Adjunctive Tool In The Diagnosis And Follow-Up Of Patients With Optic Neuritis And Papilloedema. Larger Studies With Longer Follow-Up Periods Are Recommended To Further Establish The Prognostic Value Of Rnfl And Gcl Measurements In Predicting Visual Outcomes And Disease Progression.

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