Evaluation of the Retinal Nerve Fibre Layer and Ganglion Cell Layer with Optical Coherence Tomography among Patients with Alcohol Abuse

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Abstract

Introduction: Alcohol consumption is considered as a major public social problem. A significant number of individuals are affected by alcohol intake resulting in irreversible vision loss, due to damage to the mitochondria that prevents oxidative phosphorylation from occurring, which results in axonal loss.

Objective: This study assesses the retinal nerve fibre layer thickness and ganglion cell layer thickness in subjects and correlates with the severity of alcohol intake.

Methodology: This crosssectional study was carried out in Sri Manakula Vinayagar Medical College and Hospital, Puducherry under the Department of Ophthalmology. Patients with at least 5 years of alcohol use were included in the study. Personal details of the patient with detailed medical history were noted. Severity of alcohol use was graded by Alcohol Use Disorders Identification Test (AUDIT) scoring system for alcohol use. Thorough eye examination were done for all patients including visual acuity, colour vision and slit lamp examination of the anterior segment of the eye. Fundus examination of the disc and macula were done after pupillary dilatation with Tropicamide. OCT analysis of the RNFL and GCL were done using Topcon 3D OCT-1 Maestro 2 OCT machine. Statistical analysis was done using SPSS software version 24.0.

Result: Significant RNFL and GCL thinning were noted in patients with alcohol use. Associated smoking history was found to a confounding factor in reducing the thickness of RNFL and GCL. RNFL and GCL thickness was decreased with increasing alcohol intake which was compared with AUDIT score.

Conclusion: The present study supports the concept that RNFL and GCL thickness is influenced by severity of alcohol abuse. Since alcohol intake is found to reduce RNFL and GCL thickness, this should be taken into consideration while examining patients with alcohol abuse to prevent irreversible vision loss.

*Keywords***:** consumption, crosssectional, pupillary.

Introduction

Alcohol and tobacco are the most commonly abused substances in India. India is the world's third-largest market for alcoholic beverages due to its enormous population.[1]Alcohol and tobacco induced toxic optic neuropathy is a medical condition characterized by loss of vision as a result of damage to the optic nerve due to malnourishment brought on by alcohol consumption and cyanide found in tobacco smoke.[2] They usually present at a stage where vision recovery is not achievable. The mechanism is primarily caused by damage to the mitochondria that prevents oxidative phosphorylation from occurring, which results in axonal loss. It mostly impacts the

papillomacular bundle's parvocellular neurons causing the RNFL thinning.[2,3] Reduced Gamma-aminobutyric acid (GABA) activity, a key inhibitory neurotransmitter in the brain, may be connected to ocular abnormalities[4]

Optical coherence tomography (OCT) is a non-invasive method with high reproducibility that enables quantitative, detailed topographical examinations of the retinal nerve fibre layer (NFL) and inner retinal layers (i.e., the ganglion cell and

inner plexiform layer [GCL+]). The GCL+ reflects the health of retinal ganglion cells.[5] Studies have shown that people with alcohol use disorder (AUD) have smaller volumes of brain tissue than healthy people and light social drinkers. MRI has shown that cortical volumes of both gray matter (GM) and white matter (WM) associated with balance, muscle control and coordination are reduced in AUD.[6]

This study evaluates the retinal nerve fibre layer and ganglion call layer using optical coherence tomography among patients with alcohol abuse. This study is done to emphasize early screening with OCT to predict visual morbidity in patients with alcohol abuse.

Materials And Methods

Setting: This study was conducted in the Department of Ophthalmology of Sri Manakula Vinayagar Medical college and hospital, Puducherry - a tertiary care centre

Study design: Prospective observational - cross sectional study design

Study participants: Patients (both male and female) attending OPD in the Department of Psychiatry and Department of General Medicine.

Inclusion criteria includes patients (both male and female) with at least 5 years of alcohol use attending out patient Department of Psychiatry and Department of Medicine. Exclusion criteria includes patients who were on drugs like ethambutol and isoniazid that can cause optic neuropathy, on disulfiram for chronic alcoholism, with glaucomatous optic disc changes.

Study duration: The data collection was done for a period of approximately 18

months from the date of approval by the IEC (Nov 2022 - May 2024).

Sample size:

Considering the mean average macular thickness in alcohol use disorder patients

compared to healthy controls (282.3+/- 11.58 and 289.9+/-10.79 um) in a study by

Sesmero et al.,[1] the sample size for the present study was found to be 70 (both

assessments were done in all participants in this study). All 70 underwent both eye

measurements of the thickness of both layers at 95% confidence interval and 80%

power.

Methodology:

The cross-sectional observational study was carried out in Sri Manakula Vinayagar Medical College and Hospital, Puducherry under the Department of Ophthalmology after the approval of the ethics and research committee (EC/76/2022). Patients with at least 5 years of alcohol use attending out patient department of Psychiatry and General Medicine were enrolled in the study, after explaining the purpose of the study obtaining valid informed written consent.

Data collection procedure:

Personal details of the patient including name, age, gender, education, occupation, income were noted. A detailed medical history accompanied by a thorough eye examination was done for all patients. Severity of alcohol use was graded by Alcohol Use Disorders Identification test (AUDIT) questionnaire scoring system for alcohol use. Standard units of alcohol was used for grading the severity. Thorough ocular examination was done which included, visual acuity using Snellen's chart for distant vision which was converted into LogMAR value, Jaeger chart for near vision, Ishihara chart for colour vision, anterior segment examination was performed using slit lamp biomicroscope. IOP measurement was done using applanation tonometer. Both eyes, pupil dilatation was done with 1% Tropicamide. Post dilatation, posterior segment examination was done using direct and indirect ophthalmoscope. Each patient's macular GCL thickness and peripapillary RNFL were measured in both eyes using a Topcon SD - OCT. The RNFL over the 6x6mm^2 of the peripapillary area was imaged using the optic disc cube 200x200 scan procedure. The GCL over the

1mm of the macular region were imaged using the macular 200x200 scan procedure. The study assessed four peripapillary RNFL parameters: superior, nasal, inferior, and temporal quadrant thickness and macular GCL parameters: superior and inferior quadrant thickness. For every optic disc map and macular map, two scans were acquired and both showed good centration and a signal strength of more than 7. The case report form with the obtained data was attached to the printout of the SD-OCT of the optic disc RNFL and macular GCL.

Methods of Statistical Analysis and Tests applied:

The acquired data was entered into Epi Info version 7.2.1.0, and SPSS version 24.0

was used for analysis. The mean and standard deviation were used to describe

categorical variables, whereas percentages were used to describe gender, occupation,

and percentages were used to summarize the results of visual acuity testing. The

mean and standard deviation of the peripheral RNFL thickness were reported for the

superior, nasal, inferior, temporal, and average regions. Macular GCL thickness was

mentioned in terms of mean and standard deviation for the superior, inferior quadrant,

and average. The mean changes in RNFL and GCL thickness according to alcohol

severity were compared using the Paired T test. The Chi-square test was used to

evaluate the relationship between the changes in RNFL and GCL thickness and other

factors. A p-value (probability value) less than 0.05 was regarded as statistically

significant.

Ethical Considerations:

IEC approval number: EC/76/2022.The amount of risk was negligible. Before the clinical assessment, informed written consent was collected from each participant and a participant information document was given to them. Both study information and participant data were kept private. Every piece of information is digitally stored and encrypted

Reporting of Study:

The study was reported by following STROBE guidelines

Results:

A total number of 70 patients were included in the study, all of whom had history of

alcohol consumption for more than 5 years. Majority of study participants fell within the age range of 31-60 years (71.4%), followed by >60 years (24.3%) and 28-30 years (4.3%). Gender distribution maximum were males, comprising 83% of the respondents, while females accounted for 17.1%. Majority were daily labourers and farmers(31.4%).Among study participants, 35.2%(25) reported consuming alcohol for less than 10 years, while a 24%(17) reported durations between 11-19 years. A notable study participants, 40%(28) reported consuming alcohol for over 20 years, indicating a significant proportion with long-term alcohol consumption habits. About 41% were found to be Smokers. Notably, 18.3% of study participants reported smoking for over 20 years.

Table 1: Correlation between alcohol abuse(Audit score) - RNFL - RIGHT and LEFT EYE (n = 70)

S.no	Correlation between Retinal Nerve Fibre layer and AUDIT score Right Eye		
		r value*	p value
1.	Superior	-0.06	0.6
2.	Inferior	-0.23	0.05
3.	Nasal	-0.18	0.12
4.	Temporal	-0.20	0.09
S.no	Correlation between Retinal Nerve Fibre layer and AUDIT score Left Eye		
		r value*	p value*
1.	Superior	-0.02	0.86

S.no		r value	p value
2.	Inferior	-0.16	0.18
3.	Nasal	-0.42	0.00
4.	Temporal	0.17	0.15

spearman correlation coefficient*

In right eye, there was a moderate negative correlation between RNFL thickness in the inferior area of the retina and AUDIT score(p value of 0.05) while correlations in other areas were weak and not statistically significant. In left eye, there's a statistically significant negative correlation between RNFL thickness in the nasal area and AUDIT score, indicating that thinner RNFL in the nasal area is associated with higher AUDIT scores (p value o.oo).

Table 2: Correlation between Ganglion cell layer and AUDIT score - Right Eye and left eye (n = 70

S.no	Correlation between Ganglion cell layer and AUDIT score		
			Right Eye
		r value*	p value*
1.	Superior	-0.26	0.02
2.	Inferior	-0.26	0.02
S.no	Correlation between Ganglion cell layer and AUDIT score		
			Left Eye
		r value*	p value*
1.	Superior	-0.29	0.01
2.	Inferior	-0.22	0.06

spearman correlation coefficient*

In right eye, the p value being 0.02 in both superior and inferior layers indicate a statistically significant negative correlation between AUDIT score and thinning of GCL. In left eye, there's a significant negative correlation between GCL thickness in the superior area of the retina and AUDIT score. However, in the inferior area, while there is a negative correlation, it is not statistically significant, suggesting that the relationship may not be as strong as observed in the superior region.

In both eyes, there's no significant correlation between smoking and RNFL thickness in any of the specified areas of the retina. The correlations observed are weak and not statistically significant.

Discussion:

The results of our study show that chronic alcoholics exhibit a significant thinning of retinal nerve fibre layer (RNFL) in inferior quadrant in right eye and nasal quadrant in the left eye. Significant thinning of the ganglion cell layer was seen in the superior and inferior quadrant in the right eye while only superior quadrant thinning was noted in the left eye. These impairments in RNFL and GCL layers were found to correlate with the quantity of alcohol consumption calculated by AUDIT score. In our study, majority of study participants fell within the age range of 31-60 years (71.4%), predominantly males(83%) with many of them being unemployed and belonging to middle and lower middle class. The median AUDIT score among respondents was 10.5, with an interquartile range (IQR) ranging from 6 to 19.This indicates a wide range of alcohol use behaviours and potential risk levels within the study population.

Sesmero et al compared in their study the thickness of RNFL and alcohol consumption and compared with AUDIT score. Unlike our study, no statistical significance was found in their study.[7] Similar to this, Ahuja et al did a study and found out that in all cases RNFL thickness was considerably lower than that of the controls, in all quadrants.[8] This is consistent with the research by Moura et al[9] who used Stratus OCT to assess RNFL measurements in three cases of tobacco-alcohol-induced ocular neuropathy and discovered RNFL thinning in two of them. This was also found to be in accordance with a study by de Lima Rde et al[10] that assessed RNFL in chronic alcohol and tobacco users using GDx. According to the findings in their studies, long-term alcohol and tobacco use was found to be linked to changes in the nerve fibre layer.

In the present study, in the right eye, there was a moderate negative correlation between RNFL thickness in the inferior area of the retina and AUDIT score (p 0.05). In the left eye, there's a statistically significant negative correlation between RNFL thickness in the nasal area and AUDIT score (p 0.00), indicating that thinner RNFL in the nasal area was associated with higher AUDIT scores.

However, correlations in other areas in both eyes were weak and not statistically significant.

When the correlation between the GCL and AUDIT score were evaluated in our study, the right eye showed statistically significant negative correlation In both the superior and inferior quadrants between GCL thickness and AUDIT score(p 0.02) and in the left eye, there's a significant negative correlation between GCL thickness in the superior area of the retina and AUDIT score (p 0.01). However, in the inferior area, while there is a negative correlation, it is not statistically significant (p 0.06), suggesting that the relationship may not be as strong as observed in the superior region.

The present study shows in both eyes, no significant correlation between smoking and RNFL thickness in any of the specified areas of the retina while statistically significant positive correlation between smoking and GCL thickness in the inferior area of the retina is seen.

Among study population, Diabetes was seen in 54% while Systemic Hypertension was found to be 32.3% within the other comorbidity. About 45% reported having diabetes for less than 10 years. A smaller proportion, 8.5%, reported having diabetes for a duration ranging from 11 to 20 years. But in our study, no significant correlation was found between comorbidity and its duration with thinning of RNFL and GCL.

Conclusion:

The present study supports the concept that RNFL and GCL thickness is influenced by severity of alcohol abuse. Since alcohol intake is found to reduce RNFL and GCL thickness, this should be taken into consideration while examining patients with alcohol abuse to prevent irreversible vision loss.

Strength: We correlated the severity of RNFL and GCL thinning with the severity of addiction using AUDIT score. The effect of smoking in addition to alcohol over the thinning of the RNFL and GCL were studied and significant correlation was found between them. Comparison of sociodemographic details like age, gender, occupation, family income and socioeconomic status were done among our study participants which showed majority of the participants were unemployed and belonged to the middle and lower middle class. This comparison was not done in the earlier studies.We have used 3rd generation SD OCT, that facilitates high-resolution and high-speed RNFL imaging, which makes our study results more accurate.

Limitation: Less number of pure alcoholics had been recruited in the study which leads to selection bias. Small sample size limits the generalization of our results.

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