

Assessment of Macular Ganglion Cell/Inner Plexiform Layer Thickness with Swept Source Optical Coherence Tomography in Glaucoma Patients: A Comparative Study with Retinal Nerve Fiber Layer Measurements

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ABSTRACT

Purpose: To assess the thickness of Macular ganglion cell/inner plexiform layer in glaucoma patients by using swept-source OCT and compare it with peripapillary RNFL thickness.

Study Design: Descriptive Cross-Sectional Study.

Place and Duration of Study: Liaquat University of Medical and Health Sciences Jamshoro from June 2021 to June 2022.

Methods: Total 140 patients were enrolled in our study and divided in two groups. Group A included patients diagnosed with glaucoma and group B (control group), included non-glaucoma patients. Patients of either gender, above 30 years of age or intraocular pressure (IOP) of more than 21 mm Hg with open angle on gonioscopy were included in the study. All participants underwent examinations including visual acuity, refraction, IOP measurement, Gonioscopy, slit lamp examination with dilated fundus examination. Swept source OCT measurements Ganglion cell layer/inner plexiform layer (GCL/IPL) and Retinal nerve fiber layer (RNFL) thickness were measured. The independent t test and the chi-square were used. P-values less than 0.05 were deemed statistically significant.

Results: There were 65.7% males and a mean age of 46.8±12.08 years. Glaucoma cases showed significantly higher IOP and cup to disc ratio compared to controls ($p<0.001$). RNFL and GCIPL thickness was markedly reduced in glaucoma eyes versus controls ($p<0.001$). GCIPL demonstrated strong discriminatory ability similar to RNFL for detecting glaucomatous changes.

Conclusion: GCIPL thickness showed diagnostic performance comparable to RNFL measurements. Incorporating GCIPL assessment may enhance early and reliable detection of glaucoma.

Keywords: Gonioscopy, Ganglion cell layer, Inner plexiform layer, Retinal nerve fiber layer, Glaucoma, Intraocular pressure.

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INTRODUCTION

Glaucoma is defined as optic neuropathy, which is progressive and is characterized by loss of retinal ganglion cells (RGCs) and its axons, which correlate with characteristic changes in Optic Nerve Head (ONH) and Retinal Nerve Fiber Layer (RNFL) along

with defect in visual field.¹⁻³ The number of people with glaucoma worldwide will increase to 111.8 million in 2040, disproportionally affecting people residing in Asia and Africa.^{4,5} Glaucoma assessment, requires both functional and structural evaluation in the form of visual acuity, visual field by perimetry, optic nerve head and retina, done through examination of fundus and Optical Coherence Topography (OCT).⁶⁻⁹

This study aims to find out the macular GCL/IPL thickness and compare it with peripapillary RNFL thickness in glaucoma and non-glaucoma patients.

METHODS

This descriptive cross-sectional study was conducted at Liaquat University of Medical and Health Sciences Jamshoro from June 2021 to June 2022. The study was approved by the Institutional review board/Ethical review board (LUMHS/REC/-42). Total 140 patients were enrolled after informed consent. Patients were divided in two groups of equal sizes, i.e., 70 patients per group. Group A (case group) included patients with glaucoma and group B (control group), included individuals without glaucoma. Patients of either gender, above 30 years of age or IOP of more than 21 mm Hg with open angle on gonioscopy were included in the study. Patients with dense cataract, neurological disorder or any other posterior segment disease were

excluded from the study. All recruited participants underwent complete history and ocular examinations which included visual acuity, refraction, IOP measurement, Gonioscopy, slit lamp examination with dilated fundus. Swept source OCT for average RNFL thickness (Figure 1a) and macular GCL/IPL (Figure 1b, 1c) were measured. Data was analyzed using SPSS version 20. Continuous variables as age, IOP and cup to disc ratio (CDR), GCIPL, RNFL, and visual acuity were provided as mean $\pm$ standard deviation. Categorical variables were reported as proportions and percentages. Independent t test and the chi-square tests were used for analysis. P-values less than 0.05 were deemed statistically significant.

RESULTS

A total of 240 eyes from 140 participants were recruited, including 106 eyes from 70 cases (glaucoma) and 134 control eyes from 70 subjects, out of which 92 (65.7%) were males and 48 (34.3%) were females (Figure 1). The mean age of the whole sample was 46.8 ± 12.08 . Whereas mean age of cases was 53.67 and controls were 44.08 years.

Table 1 shows descriptive statistics of the study sample.

Table 2 shows the t-test results for comparison between the groups.

Table1: Descriptive statistics of variables in both groups (CDR= cup to disc ratio, IOP= intraocular pressure).

Variable	Mean	Standard Deviation
IOP right	19.55	9.89
IOP left	17.65	4.78
CDR right	0.6488	0.18205
CDR left	0.6658	0.43243
Retinal nerve length fiber in right eye	83.6899	29.91336
Retinal nerve length fiber left eye	88.7297	26.91838
Ganglion cell layer/inner plexiform layer right eye	61.0155	13.93567
Ganglion cell layer/inner plexiform layer/left eye	62.7568	13.28719

Table 2: T test of both groups showing comparison of variables.

Independent T test									
Case					Control				
Variables	Mean	St.de	T-value	Sig	Variables	Mean	St.de	T-value	Sig
IOP(R)	23.45	1.945	4.57	0.00	IOP(R)	16.044	12.54	4.81	0.00
IOP(L)	22.97	1.658	24.95	0.00	IOP(L)	14.030	1.976	25.79	0.00
CDR(R)	0.78	0.115	11.17	0.00	CDR(R)	0.52	0.141	11.29	0.00
CDR(L)	0.82	0.504	3.23	0.002	CDR(L)	0.56	0.341	3.012	0.004
RNFL(R)	56.8	20.21	-18.34	0.00	RNFL(R)	107.7	10.12	-17.16	0.00
RNFL(L)	61.64	20.31	-15.82	0.00	RNFL(L)	107.2	9.63	-14.01	0.00
GCL/IPL(R)	49.82	11.69	-13.34	0.00	GCL/IPL(R)	71.05	5.67	-12.9	0.00
GCL/IPL(L)	49.97	11.10	-13.81	0.00	GCL/IPL(L)	71.46	5.008	-12.16	0.00

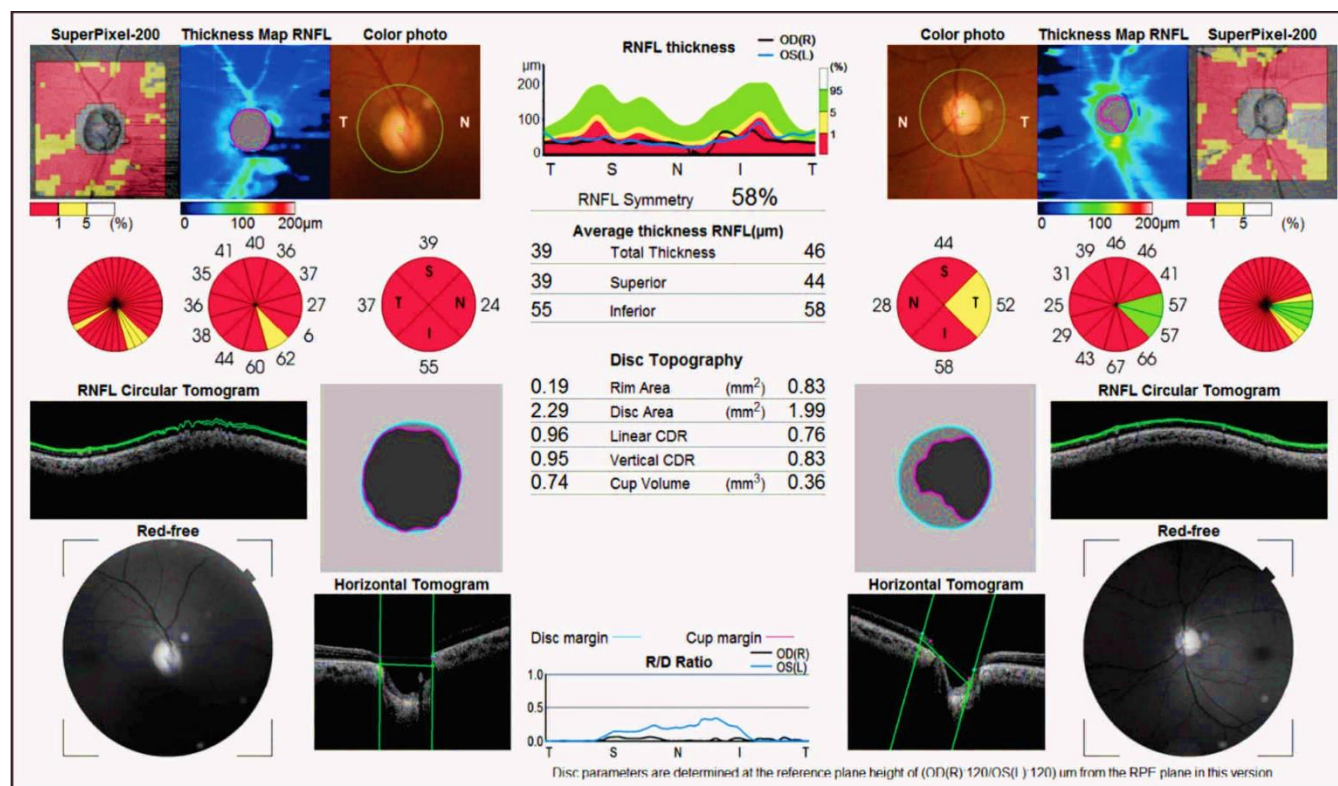


Figure 1a: RNFL measurements of both eyes.

DISCUSSION

Structural changes are assessed by circum papillary retinal nerve fiber layer (cpRNFL) corresponding to retinal nerve fiber layer (RNFL) loss and macular ganglion cell layer damage reflecting loss of RGCs.¹⁰⁻¹³

For glaucoma, two individual scans, one for cpRNFL measurement and one of macula has to be taken, but Swept Source OCT (SS-OCT), new OCT technology, with longer wavelength and faster scanning speed can scan wider area of 12 x 9 mm of posterior pole in single scan.^{14,15}

Glaucoma, one of the causes of global blindness, requires early detection along with meticulous assessment and monitoring of those individuals who are at highest risk of progression of disease and visual loss. OCT of macula and ONH is widely used in diagnosis and monitoring of disease.¹⁶

In the present study, males predominated, accounting for 65.7% of participants across both groups. Similarly, Abera A reported a male predominance of 52.1% in their study.¹⁷ The mean age of participants was 53.67 years in Group A and 44.08

years in Group B. Comparable findings were reported by Abera A, who observed a mean age of 58 years among glaucoma patients and 49 years in the control group. Likewise, Ozaltun OA conducted a similar study and reported a mean age of 57.29 years in glaucoma patients, comparable to Group A in the present study, and 53.77 years in the control group, which was similar to Group B.¹⁸

The mean IOP was 23.45 mm Hg in the right eye and 22.97 mm Hg in the left eye in group A, whereas in group B it was 16.04 mm Hg in the right eye and 14.03 mm Hg in the left eye. In a similar study, the mean IOP was 20.6 mm Hg, whereas in the control group it was 16 mm Hg. Ozaltun OA reported a mean IOP of 16.17 mmHg in patients with glaucoma, corresponding to Group A in the present study, while the control group, comparable to our Group B, had a median IOP of 14.07 mmHg. Similarly, in the present study, the mean IOP was higher in Group A than in Group B, consistent with the findings of previous studies.¹⁸

In the present study, the mean CDR in Group A was 0.78 in the right eye and 0.82 in the left eye, whereas in Group B it was 0.18 in the right eye and

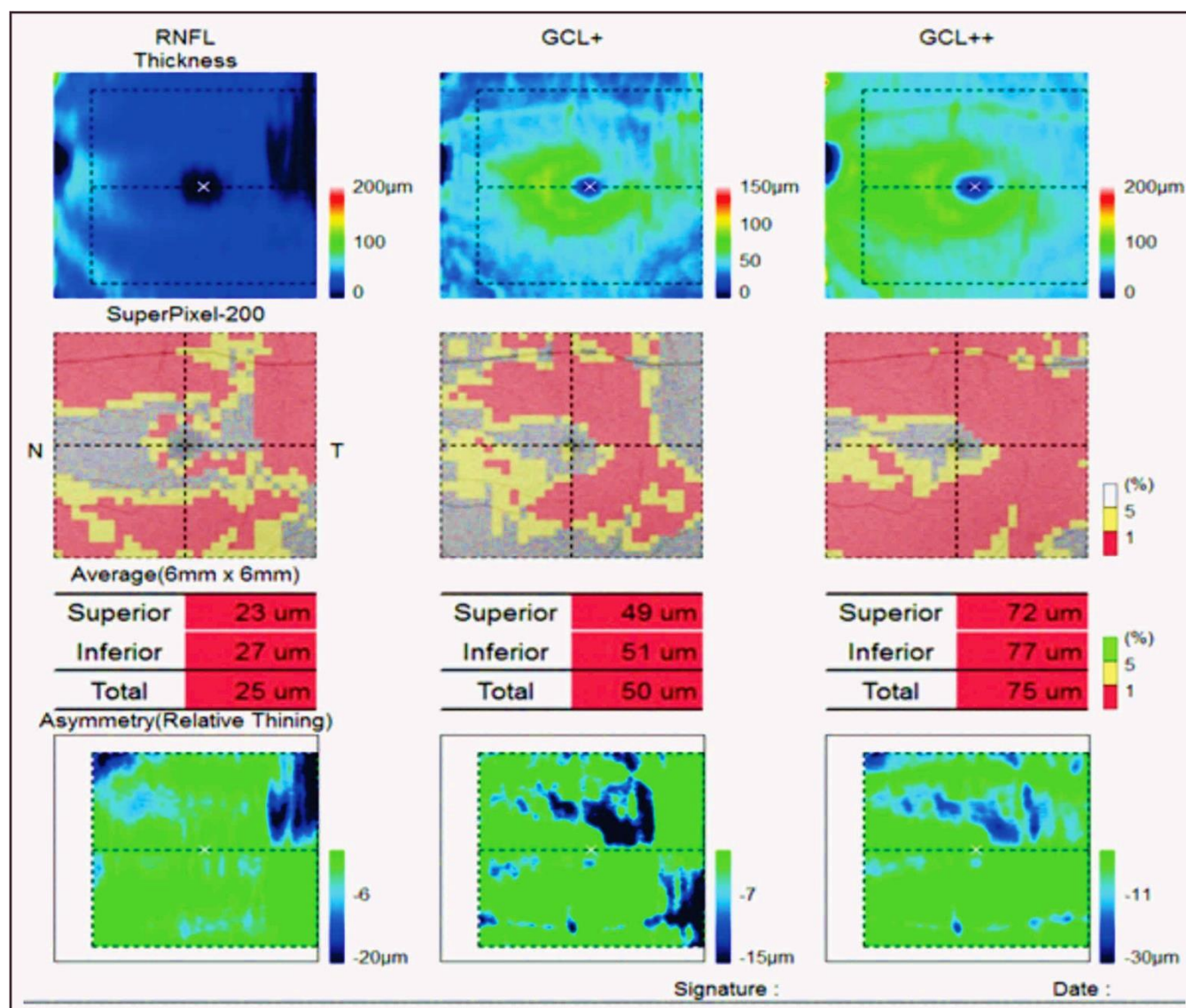


Figure 1b: Left eye GCIPL thickness.

0.43 in the left eye. Abera A reported a mean CDR of 0.61 in glaucoma patients and 0.59 in the control group.¹⁷ Similarly, Ozaltun OA reported a mean CDR of 0.66 in patients with early glaucoma and 0.55 in the control group.¹⁸

In the present study, the mean RNFL thickness in Group A was 56.8 μm in the right eye and 61.64 μm in the left eye, whereas in Group B it was 107.7 μm in the right eye and 107.2 μm in the left eye. Ozaltun OA also reported a lower average RNFL thickness in patients with early glaucoma (98.25 μm) compared with the control group (111.13 μm).¹⁸ Similarly, Acosta PC reported RNFL thickness values of 78 μm and 73 μm in patients with early and moderate

glaucoma, respectively; however, their study did not include a control group.¹⁹ Ventakataraman AP also demonstrated higher RNFL thickness values in the control group compared with glaucoma patients, although they used spectral-domain optical coherence tomography (SD-OCT) rather than swept-source OCT.²⁰

In the present study, the mean GCL/IPL thickness in Group A was 49.82 μm in the right eye and 49.97 μm in the left eye, whereas in Group B it was 71.05 μm in the right eye and 71.46 μm in the left eye. Ozaltun OA reported a mean GCIPL thickness of 66.99 μm in patients with early glaucoma and 73.76 μm in the control group.¹⁸ Similarly, Acosta PC

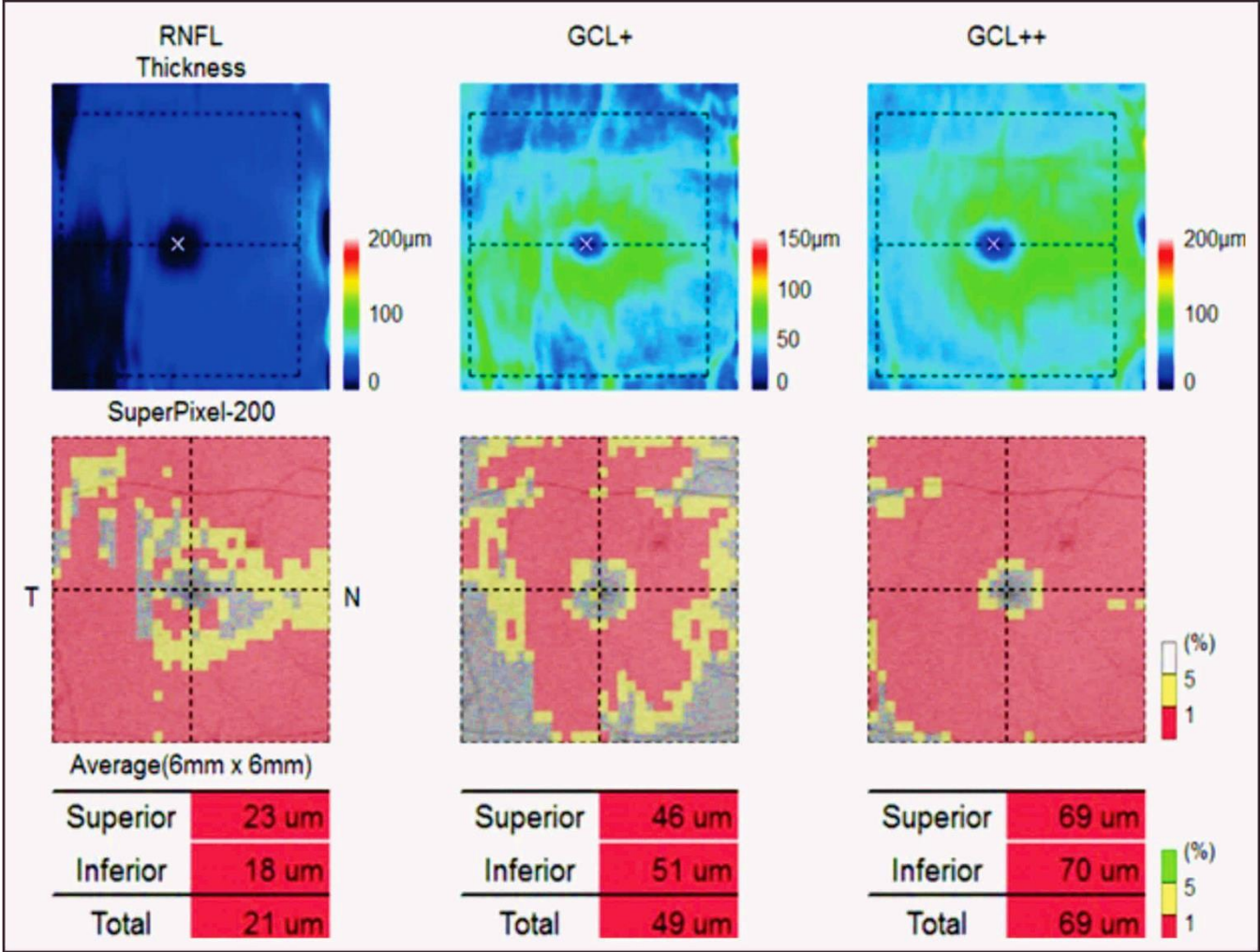


Figure 1c: Right eye GCIPL thickness
Figure 1: GCIPL and NFL thickness in glaucoma patient.

reported a mean GCIPL thickness of 68.8 μm in glaucoma patients.¹⁹ Ventakaraman AP also demonstrated higher GCIPL thickness values in the control group compared with glaucoma patients.²⁰

Several limitations of the present study should be acknowledged. First, the sample size was relatively small, which may limit the generalizability of the findings. Second, the study was conducted at a single center, and therefore the results may not be representative of the wider population. Third, the cross-sectional design of the study precluded assessment of longitudinal changes in retinal nerve fiber layer (RNFL) and ganglion cell layer/inner plexiform layer (GCL/IPL) thickness over time. In addition, inter-eye variability was analyzed separately, whereas some previous studies reported combined averages for both eyes, which may limit direct

comparison. Another limitation was the inclusion of only selected stages of glaucoma, which may not fully reflect structural changes across the entire spectrum of disease severity. Finally, comparisons with previous studies should be interpreted cautiously, as different studies utilize different optical coherence tomography (OCT) platforms, particularly spectral-domain OCT and swept-source OCT, which may influence measurement values.

CONCLUSION

The present study demonstrated significantly reduced RNFL and GCL/IPL thickness in patients with glaucoma compared with healthy controls. Measurement of RNFL and GCL/IPL thickness may aid in the early detection and evaluation of glaucoma

and can serve as an important adjunct in the diagnosis and monitoring of disease progression. GCIPL thickness showed diagnostic performance comparable to RNFL measurements. Incorporating GCIPL assessment may enhance early and reliable detection of glaucoma.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board (LUMHS/REC/-42)

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Authors Designation and Contribution

Asif Chandio; Consultant Ophthalmologist: *Concepts, Design, Literature Search, Data Acquisition.*

Asadullah Jatoi; Associate Professor: *Literature Search, Data Acquisition, Data Analysis, Statistical Analysis.*

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Ghazi Khan Mari; Assistant Professor: *Manuscript Preparation.*

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