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Correlations between peripapillary retinal nerve fiber layer thickness and macular thickness in different stages of primary open-angle glaucoma, an OCT study

Osama M.Mohamed, Ashraf H.El Habbak, Tamer I.Salem and Mohamed A.Awwad
Ophthalmology Dept., Faculty of Medicine, Benha University, Benha, Egypt
E-mail: osamatarget777@gmail.com

Abstract:
Background: Progressive optic nerve degeneration and loss of visual field are hallmarks of primary open-angle glaucoma, the most common cause of permanent blindness globally. The evaluation of structures in glaucoma has become an essential technique. The evolution of technique gives better understand by examining the nerve fibre layer associations at stages of the illness. The purpose of this is to examine the correlations in all phases.
Methods: Fifty eyeballs from fifty patients were collected from Ophthalmology Outpatient clinics for this comparative cross-sectional investigation. Group A included 25 eyes of patients with primary open-angle glaucoma; group B included 25 eyes of healthy volunteers as a comparison. Pupil response, visual acuity testing, anterior segment evaluation, gonioscopy, intraocular pressure measurement, and fundus examination were all part of the comprehensive ophthalmologic evaluations. and measures were collected, and high-quality pictures of the peripapillary region and macula were taken utilising Spectral-Domain imaging.
Results: The There were statistically significant variations in BCVA, MD between the control and patient groups. Some parts of the macula were shown to have very high correlations with peripapillary. Predictive accuracy varied among phases, as seen by the ROC analysis.
Conclusions: Differences in the control and patien groups are highlighted by this research. With varied predictive accuracy throughout disease stages, emerges as a viable diagnostic tool.
Keywords: Primary, open-angle glaucoma, nerve fibre layer.

Introduction:

Glaucoma is a degenerative condition that attacks the retinal ganglion cells over time and eventually causes permanent vision loss. Glaucoma is a leading cause of irreversible blindness if not properly diagnosed and treated. Over 66 million individuals throughout the world are thought to have glaucoma right now. If we can learn more about how glaucoma progresses, we can cut down the number of people who become blind from it and the money spent treating them. Evidence of functional impairment (as determined by the visual field) or anatomic damage at the level of the optic nerve disc or of the nerve fibre layer is required for a diagnosis of primary open-angle glaucoma [1].

Even when extensive nerve fibre loss, the visual field loss and distinctive optic disc alterations of glaucoma are not detectable [2].

Since glaucomatous damage is permanent, prompt treatment relies on early diagnosis of ganglion cell injury. Changes in the peripapillary thickness is an early indicator of glaucoma [3], even before the optic disc and visual field symptoms manifest.

Axons from ganglion cells, as well as astrocytes and Müller cell processes, make up the bulk of the . When compared to the macula, the number of ganglion cells in the peripheral retina is lower. The macula contains four to six layers of ganglion cells, but the ganglion cell layer is just one cell thick outside the macula [4].

Macula is composed of 30–35% ganglion cells. Thus, ganglion cell atrophy has been primarily blamed for macula thinning in glaucoma [3].

The value of a macula evaluation in glaucoma is being reevaluated with the advent of the new SD-method. This instrument's high resolution allows for a more thorough examination of the macula in less time, which significantly increases the area evaluated and decreases the need for interpolation, resulting in more precise and repeatable readings. However, glaucoma analysis has limited applicability. Thus, a strong association abnormalities and glaucoma has been seen in certain patients, but not others. However, -detected thinning has been linked to more severe visual field loss in both early and late stages of glaucoma [5].

Thikness was observed by the Topcon 3D OCT FA. examined regions (macula, ganglion cell complex, and RNF). In glaucoma patients the ganglion cell complex in the inferior temporal outer sector was reported to be the most useful variable (area under the ROC curve 0.86; [6]).

Loss of ganglion cells may be simpler to detect than that in the peripheral retina due to the multilayer structure of these cells' bodies.

Therefore, could be a better choice for diagnosing glaucoma in individuals with peripapillary atrophy or extremely small or large discs [7].

In order to better understand the progression of primary open-angle glaucoma, this research attempted to measure the correlation between macular thicknes and peripapillary etinal nerve fiber thickness.

Patients and Methods:

This stud took place from November 2022 to May 2023, researchers at Benha University Hospital's Ophthalmology Outpatient Clinics studied 50 eyes from 50 participants using a case-control design. Before beginning the research, permission was granted by the Ophthalmology Department and Ethics Committee of the Faculty of Medicine at Benha University (Approval code: MS 31-10 2022). All participants provided their informed written permission, and to protect their anonymity,

they were each given a code number. Patients above the age of 18 who had been diagnosed with primary open-angle glaucoma were eligible. Subjects in the control group had to be free of macula-threatening conditions such hypertension and diabetes. All subjects had to meet criteria for imaging, including the absence of posterior segment disease and a refractive error of less than 5 diopters in the spherical equivalent. Retinopathy, treatment, or any intraocular complicated surgical operations were also disqualifiers, as were any medications that may have an effect on the retina.

Any disease of the posterior segment, other than glaucoma, that may have an effect on the macula was a disqualifying factor. Refractive errors more than 5 diopters spherical, a history of retinopathy, treatment, or previous intraocular complicated surgical operations were all insurmountable barriers to participation. Existing drug side effects on the retina further disqualified patients from participation.

Patients over the age of 18 with a diagnosis of primary open-angle glaucoma were separated from healthy volunteers who had unremarkable ophthalmological exams to form the "case" group. Chronic progressive optic neuropathy, manifested by thinning of nerve fibres, glaucomatous optic nerve damage, characteristic visual field loss, an open anterior chamber angle, and the absence of signs indicating secondary glaucoma or non-glaucomatous causes of optic neuropathy were used to diagnose primary open-angle glaucoma [8].The following procedures were performed on every patient:

An extensive patient history was collected during the first stage of the process. Important demographic information was collected, including participants' ages and sexes, so that researchers could examine the demographics of the sample. Blurred vision, loss of visual field, and other difficulties in seeing things were among the particular visual issues participants were questioned about.

Patients were also asked about any eye conditions or operations they had in the past, with a focus on glaucoma. In addition, participants were questioned regarding the presence of comorbidities or systemic variables that may have affected the results, such as diabetes, hypertension, or autoimmune illnesses.

Finally, participants were asked about any medicines they were currently taking, such as eye drops, oral pills, or systemic treatments, to help rule out any possible confounding variables.

A comprehensive ophthalmologic examination was performed as the second step in the approach. Several crucial facets of eye health were evaluated in this checkup. The pupils' ability to constrict and enlarge normally was measured by monitoring their "reaction time." Snellen's chart testing was used to determine the individual's BCVA after taking into consideration the best possible corrective lenses.

Anterior segment anomalies were sought for by using a slit lamp biomicroscope to examine the cornea, iris, lens, and anterior chamber of the eye. The iridocorneal angle was observed using a Goldman three-mirror gonio lens in order to evaluate drainage channels and spot any anomalies or evidence of angle closure. An applanation tonometer was used to monitor intraocular pressure (IOP), giving vital data for identifying and treating glaucoma. In order to detect anomalies like cupping of the optic disc or haemorrhages in the optic nerve head, a fundus examination was performed.

In addition, each applicant was given a perimetry exam utilising a Humphrey Field Analyzer model 745I to evaluate their peripheral vision. Participants were then classified into incipient glaucoma, intermediate glaucoma, or advanced glaucoma based on the mean defect (MD) of their visual field, as measured using perimetry tests [10].

A) C. in the Spectral Domain (SD-) for Structural Analysis:

After pharmacological pupil dilatation, SD-examinations were performed using 3D 2OOO FA instrument. variables examined included both the centre and periphery [11] and nerve fibre layer at each of the 12 clock positions.

For investigations, pupils were dilated with 1% cyclopentolate eye drops [12]. Thickness of the macula was measured using a 4-quadrant, 12-hour, and total circum papillary scan average, with aberrant thinning determined by a measurement that fell beyond the 95% normal range and was verified by at least 2 of 3 further scans. This measurement helped differentiate normal eyes and eyes with varying degrees of functional loss due to glaucoma.

Sample size calculation:

The G. power 3.1.9.2 (University of Kiel, Germany) was used for the sample size computation. Using data from a prior work [8], we determined that there was a significant relationship p at the 7 o'clock sector and the inferior inner area ($r = 0.632$; P 0.001). In light of the following factors, 80 percent research power, 0.05 error, 1:1 allocation ratio. Dropout was compensated for by adding 7 more instances. As a result, 50 people were selected.

Statistical analysis:

For the statistical analysis , we used IBM SPSS Statistics for Windows, Version 25 (IBM Corp. Released 2017). This software allowed us to evaluate, code, and tabulate all of the data we had gathered. Armonk, New York: IBM Corp., 2015, IBM SPSS Statistics for Windows, Version 25.0. The Shapiro-Wilk test was used to determine whether the data followed a normal distribution. Mean and standard deviation (SD) for numerical data and frequency and percentage for non-

numerical variables were reported as part of the descriptive statistics analysis. The Student T Test was used to compare means two groups, the Mann Whitney U test was used to compare non-parametric variables, the One-way ANOVA was used to compare parametric variables more than two groups, and the Chi-Square test was used to analyse associations qualitative variables. The degree of connection two numerical variables was evaluated using correlation analysis. The ROC Curve was used to assess the diagnostic measures' sensitivity and specificity, and a cutoff point that maximised the AUC was determined. When using a 95% confidence interval, a p-value of less than 0.05 was declared statistically significant.

Results:

The Fifty participants were split evenly into control group and patient group. The mean age of patient group was 58.96 years in comparison to control group's average age which was 53.52. The patients group was 56% male while the control group was 48% male. When comparing the two groups by age and gender, there were no discernible differences. Basic data (spherical equivalent, best-corrected visual acuity (BCVA) in logMar, intraocular pressure (IOP) in mmHg, mean deviation (MD) in db) demonstrates that patients had poorer BCVA compared to controls (P = 0.019) and lower MD compared to controls (P = 0.001). Table 1

Table (1) Information on the examined populations, including demographics

		Controls n=25	n=25	test	p
Age	M±SD	53.52±9.6	58.96±11.4	t=1.842	0.121
	Range	42-72	40-73		
Gender	Male	12(48%)	14(56%)	X^2=0.321	0.571
	Female	13(52%)	11(44%)		
BCVA (logMar)	M±SD	0.3±0.12	0.43±0.2	2.633	0.019*
	Range	0.12 to 0.63	0 to 0.82		
MD (db)	M±SD	0.35±0.51	-9.34±4.93	9.771	<0.001*
	Range	0 to 1.8	-17.17 to -1.13		
IOP (mmHg)	M±SD	12.03±0.75	13.02±0.65	0.049	0.235
	Range	12 to 14.39	12 to 14.81		
Spherical equivalent	M±SD	-3.84±0.94	-3.95±1.07	0.047	0.983
	Range	-5 to -2.06	-5 to -1.16		

t = paired t-test, X2 = Chi-Square

Parameters measured in the macula using Except for fovea and nasal outer macula, all measures of were significantly different glaucoma and normal subjects. **Table 2**

Table (2) Measurements of in the sampled populations

	Controls n=25	n=25	Z	p
Fovea (µm)	231.8±15.32	227.31±14.08	1.155	0.248
Inferior inner macula (µm)	295.34±10.7	273.49±43.95	2.146	0.031*
Temporal inner macula (µm)	192.72±7.78	184.97±9.22	3.153	0.001*
Superior inner macula (µm)	298.27±9.92	294.81±11.57	0.980	0.326
Nasal inner macula (µm)	304.58±11.87	292.78±14.89	2.902	0.003*
Inferior outer macula (µm)	246.63±10.57	229.25±14.98	3.897	<0.001*
Temporal outer macula (µm)	246.29±10.24	231.49±10.23	4.013	<0.001*
Superior outer macula (µm)	259.51±10.56	242.9±9.79	4.515	<0.001*
Nasal outer macula (µm)	271.17±9.55	265.53±13.45	1.291	0.196

"Z" = "Mann-Whitney U"

Parameters measured in the macula using Researchers identified statistically significant changes in glaucoma patients and healthy controls across a number of different time points and locations. **Table 3**

Table (3) Measurements of nerve fibre among the groups

	Controls n=25	n=25	Z	p
Superior quadrant (mm)	128.21±7.81	117.22±10.63	3.697	<0.001*
Nasal quadrant (mm)	96.1±10.56	91.64±9.82	1.193	0.232
Inferior quadrant (mm)	138.83±14.18	113.07±12.95	5.074	<0.001*

Temporal quadrant (mm)	90.01±12.33	80.62±7.69	2.591	0.009*
1 (µm)	128.63±16.98	117.73±14.82	1.799	0.072
2 (µm)	104.09±11.72	106.28±15.29	2.400	0.016*
3 (µm)	89.41±10	82.69±10.39	0.631	0.528
4 (µm)	93.53±13.22	90.32±15.9	2.164	0.03*
5 (µm)	118.26±13.94	112.16±13.42	0.806	0.42
6 (µm)	144.38±18.59	1191.07±24.59	1.466	0.142
7 (µm)	143.46±17.16	113.97±27.05	6.066	<0.001*
8 (µm)	90.83±11.05	87.34±15.43	4.104	<0.001*
9 (µm)	80.52±10.75	72.36±9.18	0.786	0.431
10 (µm)	99.39±11.43	96.16±16.04	2.612	0.008*
11 (µm)	135.65±17.31	118.8±19.59	1.136	0.256
12 (µm)	124.6±12.79	116.67±20.72	3.232	0.001*
Average (mm)	109.58±5.8	100.11±7.01	4.185	<0.001*

Z = Mann-Whitney U-Test.

There was a statistically significant difference in the mean of the nerve fibre layer the early and advanced stages of glaucoma compared with healthy controls. Thinning occurred at a rate of 11.56 percent in patients with early glaucoma, 22.85 percent in those with intermediate glaucoma, and 40.68 percent in those with severe glaucoma.**Figure 1**

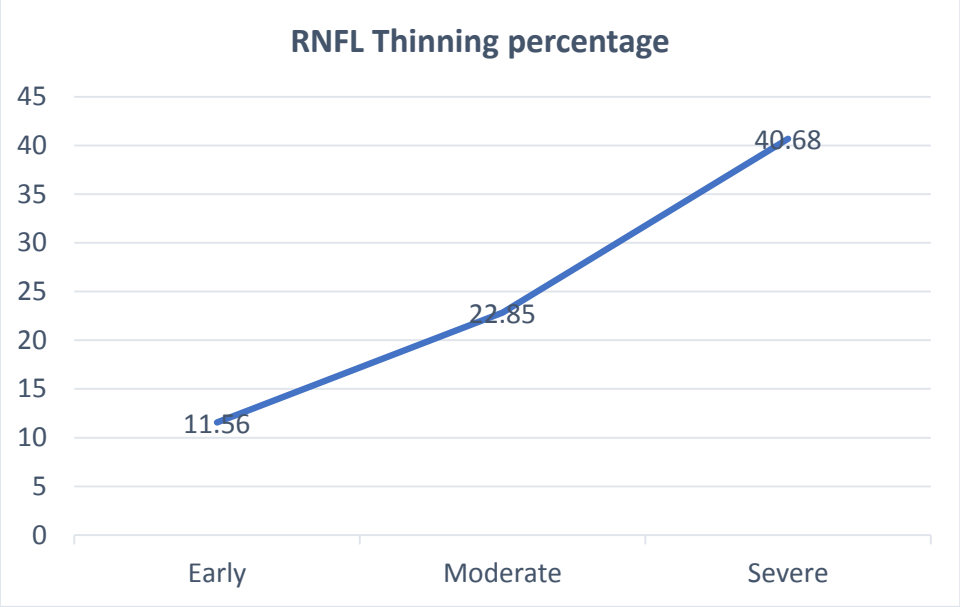


Fig. (1) Percentage of thinning at stages of glaucoma

The 7 o'clock sector and the inferior inner area had the greatest connection (r=0.637, p0.001) among all patient groups studied. Table 4

All glaucoma patients' and macula were correlated (Table 4).

		FOV	SIM	SOM	NIM	NOM	IIM	IOM	TIM	TOM
1	r	0.016	0.358	0.391	0.324	0.410	0.365	0.307	0.344	0.328
	p	0.877	0.011	0.006	0.002	0.005	0.001	0.009	0.009	0.001
2	r	-0.002	0.358	0.402	0.282	0.374	0.431	0.388	0.423	0.434
	p	0.950	0.009	0.010	0.008	0.002	0.001	0.004	0.008	0.002
3	r	0.102	0.356	0.368	0.262	0.289	0.358	0.321	0.389	0.382
	p	0.284	0.008	0.004	0.011	0.008	0.001	0.004	0.010	0.001
4	r	0.016	0.283	0.340	0.198	0.319	0.297	0.321	0.274	0.283
	p	0.008	0.007	0.001	0.039	0.003	0.001	0.001	0.030	0.008
5	r	0.104	0.373	0.417	0.348	0.489	0.498	0.500	0.423	0.438
	p	0.297	0.010	0.006	0.005	0.007	0.001	0.004	0.003	0.008
6	r	0.090	0.417	0.459	0.445	0.563	0.611	0.556	0.501	0.496
	p	0.336	0.005	0.009	0.003	0.007	0.001	0.005	0.009	0.002
7	r	0.153	0.408	0.392	0.475	0.607	**0.637**	0.610	0.493	0.467
	p	0.104	0.010	0.003	0.005	0.010	0.001	0.003	0.001	0.011
8	r	0.532	0.420	0.323	0.515	0.592	0.546	0.432	0.409	0.294

	p	0.048	0.001	0.003	0.007	0.003	0.001	0.006	0.006	0.003
9	r	0.093	0.282	0.225	0.246	0.252	0.189	0.119	0.146	0.157
	p	0.331	0.006	0.015	0.016	0.014	0.041	0.227	0.127	0.110
10	r	0.091	0.524	0.610	0.421	0.518	0.437	0.421	0.450	0.469
	p	0.338	0.007	0.002	0.003	0.011	0.001	0.010	0.006	0.005
11	r	0.154	0.508	0.612	0.433	0.523	0.474	0.382	0.492	0.508
	p	0.107	0.010	0.003	0.002	0.003	0.001	0.010	0.003	0.001
12	r	0.023	0.374	0.450	0.352	0.445	0.407	0.351	0.377	0.373
	p	0.881	0.006	0.004	0.001	0.002	0.005	0.008	0.003	0.008

r=Pearson correlation; FOV = foveal ; SIM = superior inner macula; SOM = superior outer macula; NIM = nasal inner ; NOM = nasal outer macula; IIM = inferior inner macula; IOM = temporal inner macula; TOM = temporal outer macula.

The 8 o'clock (temporal inferior) was most strongly correlated with the inferior inner area in the cohort of individuals with early (r = 0.704; P = 0.006). Correlation nerve fibre layer and central in individuals with early glaucoma.

		FOV	**SIM**	**SOM**	**NIM**	**NOM**	**IIM**	**IOM**	**TIM**	**TOM**
1	r	-0.190	0.133	0.363	-0.145	0.003	0.010	0.108	0.006	0.162
	p	0.310	0.518	0.056	0.427	0.994	0.971	0.600	1.003	0.409
2	r	-0.094	0.073	0.252	-0.140	0.005	0.145	0.188	0.119	0.291
	p	0.616	0.734	0.194	0.446	1.000	0.463	0.333	0.548	0.127
3	r	-0.019	0.064	0.059	0.085	0.076	0.193	0.314	0.194	0.333
	p	0.922	0.759	0.796	0.683	0.713	0.330	0.102	0.325	0.082
4	r	-0.289	0.022	0.228	-0.119	0.034	-0.091	0.099	-0.152	0.061
	p	0.121	0.923	0.243	0.516	0.889	0.601	0.609	0.412	0.773
5	r	-0.180	-0.058	0.159	-0.156	-0.004	0.036	0.158	-0.060	0.098
	p	0.334	0.739	0.424	0.397	0.987	0.899	0.416	0.741	0.616
6	r	-0.128	0.068	0.355	-0.055	0.137	0.265	0.470	0.188	0.412
	p	0.489	0.728	0.068	0.736	0.505	0.173	0.013	0.342	0.024
7	r	0.178	0.162	0.189	0.146	0.271	0.444	0.590	0.325	0.384
	p	0.362	0.419	0.343	0.463	0.167	0.020	0.004	0.088	0.039
8	r	0.610	0.542	0.210	0.679	0.641	**0.704**	0.592	0.484	0.194
	p	0.002	0.006	0.288	0.006	0.002	0.006	0.010	0.014	0.336
9	r	0.637	0.526	-0.033	0.661	0.432	0.455	0.328	0.394	0.033
	p	0.009	0.006	0.843	0.005	0.027	0.018	0.091	0.040	0.889
10	r	0.157	0.499	0.696	0.109	0.217	0.286	0.188	0.335	0.356
	p	0.431	0.015	0.010	0.593	0.278	0.147	0.339	0.081	0.062
11	r	0.208	0.391	0.644	0.024	0.061	0.074	0.094	0.271	0.443
	p	0.279	0.037	0.006	0.910	0.789	0.721	0.663	0.158	0.018
12	r	0.050	0.117	0.422	-0.035	0.061	0.045	0.150	0.080	0.285
	p	0.809	0.548	0.031	0.819	0.787	0.828	0.449	0.692	0.141

The 10 o'clock was shown to have the highest connection with the superior inner macula for the moderate group (r = 0.588; P = 0.01). Sixth Tableal Table6. Patients with mild glaucoma have a correlation and macula .

		FOV	**SIM**	**SOM**	**NIM**	**NOM**	**IIM**	**IOM**	**TIM**	**TOM**
1	r	-0.083	0.343	0.295	0.339	0.293	0.303	-0.112	0.331	0.368
	p	0.642	0.076	0.120	0.083	0.126	0.112	0.527	0.089	0.060
2	r	-0.140	0.248	0.216	0.132	0.044	0.343	0.154	0.359	0.472
	p	0.459	0.190	0.262	0.509	0.856	0.076	0.429	0.063	0.017
3	r	0.030	0.445	0.408	0.238	0.244	0.328	0.038	0.399	0.328
	p	0.883	0.018	0.034	0.214	0.217	0.087	0.859	0.039	0.096
4	r	-0.117	0.059	0.195	-0.074	0.269	0.172	0.034	0.085	0.179
	p	0.547	0.788	0.326	0.669	0.159	0.391	0.882	0.660	0.376
5	r	-0.032	-0.046	0.128	-0.116	0.148	0.005	0.244	0.032	0.162
	p	0.871	0.778	0.517	0.544	0.460	0.996	0.204	0.901	0.411
6	r	0.111	0.047	0.045	0.214	0.188	0.212	0.137	0.225	0.117
	p	0.566	0.826	0.829	0.265	0.334	0.281	0.494	0.244	0.560
7	r	0.331	0.092	0.159	0.295	0.451	0.231	0.097	0.041	-0.085
	p	0.090	0.636	0.405	0.131	0.014	0.229	0.633	0.845	0.629
8	r	-0.298	0.230	0.061	0.189	0.390	0.264	-0.086	0.100	-0.014
	p	0.104	0.242	0.759	0.322	0.044	0.170	0.640	0.605	0.935
9	r	-0.139	0.279	0.295	0.021	0.144	0.180	-0.103	0.020	0.051

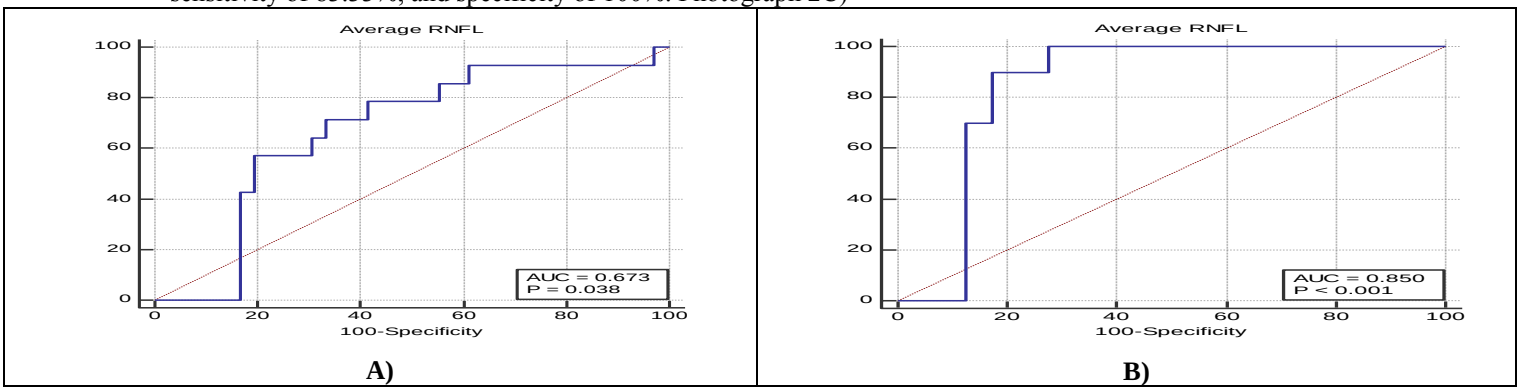
	p	0.463	0.151	0.120	0.918	0.474	0.366	0.579	0.950	0.805
10	r	0.120	**0.588**	0.541	0.449	0.302	0.327	0.207	0.427	0.254
	p	0.556	0.010	0.003	0.020	0.122	0.089	0.284	0.024	0.192
11	r	0.063	0.367	0.419	0.434	0.285	0.382	-0.040	0.384	0.363
	p	0.781	0.056	0.032	0.026	0.143	0.046	0.819	0.041	0.051
12	r	-0.197	0.443	0.442	0.477	0.337	0.353	-0.101	0.300	0.272
	p	0.289	0.021	0.023	0.018	0.079	0.067	0.567	0.119	0.158

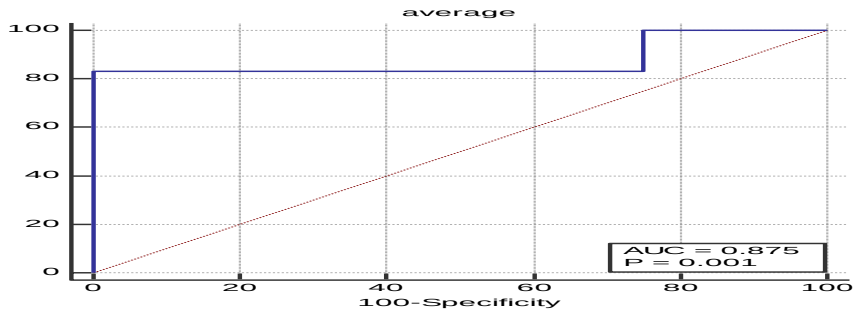
The strongest link (r = 0.581; P 0.001) was found at 4 o'clock and the superior outer macula in patients with progressive glaucoma. Table 7

Patients with advanced glaucomas have a correlation and macula , as seen in Table 7.

		FOV	**SIM**	**SOM**	**NIM**	**NOM**	**IIM**	**IOM**	**TIM**	**TOM**
1	r	0.180	0.186	0.216	0.338	0.361	0.072	-0.002	0.153	0.006
	p	0.373	0.346	0.271	0.083	0.058	0.746	0.976	0.439	0.998
2	r	0.128	0.273	0.363	0.164	0.270	0.188	0.280	0.316	0.204
	p	0.529	0.158	0.064	0.408	0.172	0.323	0.146	0.101	0.298
3	r	0.157	0.318	0.433	0.123	0.157	0.264	0.328	0.328	0.326
	p	0.435	0.096	0.020	0.540	0.434	0.175	0.091	0.092	0.089
4	r	0.472	0.504	**0.581**	0.416	0.353	0.535	0.523	0.555	0.393
	p	0.008	0.007	0.001	0.029	0.064	0.001	0.001	0.030	0.041
5	r	0.227	0.300	0.376	0.196	0.225	0.309	0.365	0.357	0.273
	p	0.253	0.115	0.049	0.313	0.234	0.107	0.056	0.062	0.151
6	r	-0.044	0.091	0.143	0.104	0.046	0.137	-0.009	0.054	0.015
	p	0.813	0.639	0.470	0.623	0.841	0.482	0.948	0.796	0.967
7	r	0.086	0.087	0.139	0.129	0.114	0.326	0.156	0.183	0.194
	p	0.676	0.684	0.479	0.511	0.583	0.084	0.434	0.361	0.313
8	r	0.048	0.221	0.271	0.225	0.318	0.151	0.112	0.170	0.174
	p	0.830	0.256	0.163	0.250	0.091	0.448	0.592	0.404	0.385
9	r	-0.088	0.226	0.216	0.277	0.313	-0.006	-0.068	0.120	0.167
	p	0.639	0.246	0.263	0.159	0.099	0.961	0.718	0.547	0.407
10	r	0.020	0.260	0.335	0.261	0.432	0.009	0.053	0.241	0.270
	p	0.966	0.181	0.076	0.181	0.020	0.974	0.812	0.207	0.164
11	r	0.346	0.347	0.433	0.388	0.469	0.162	0.053	0.383	0.191
	p	0.064	0.068	0.027	0.039	0.003	0.423	0.809	0.041	0.326
12	r	0.188	0.084	0.183	0.102	0.171	-0.003	0.093	0.140	0.031
	p	0.352	0.669	0.342	0.629	0.367	0.983	0.649	0.501	0.906

Prediction of early using the ROC curve of average revealed poor accuracy (AUC = 0.673) at the optimum cut off value (96.93), with sensitivity (%) of 71.43 and specificity (%) of (66.67). Prediction of moderate using the average (Figure 2A) yielded a ROC curve with a moderate accuracy of AUC = 0.850 at the best cut off value of 87.01, with a sensitivity of 90% and a specificity of 82.5%. Prediction of severe using the average (Figure 2B) exhibited reasonable accuracy with an area under the curve (AUC) of 0.875, best cut off value of 65.99, sensitivity of 83.33%, and specificity of 100%. Photograph 2C)





C)

Fig. 2A shows the ROC curve for predicting early glaucoma using an average . Predicting mild glaucoma using the average (B) ROC curve. Average 's ROC curve for predicting advanced glaucoma

Discussion:

Primary Open-angle glaucoma is an ocular neuropathy that progressively destroys ganglion cells, causing blindness and loss of visual field [13]. In the elderly, it is one of the leading causes of blindness. It is critical to learn about the causes of the illness and to locate accurate biomarkers to track its development ability to provide high-resolution, non-invasive imaging has made it a useful tool for assessing structural changes in ocular illnesses such as glaucoma [14]. In order to evaluate, researchers have focused on two parameters:mcula and nerve fibre layer [5, 15]. The purpose of this investigation is to examine the links between them at different phases [5, 15].

The patients in the present study had considerably worse BCVA than the controls did, as determined by spherical equivalent, intraocular pressure in millimetres of mercury (mmHg), and mean deviation in decibels (db). The patients also had a significant decline in MD compared to the controls (P 0.001).

These findings corroborate the findings of prior research showing reduced BCVA in glaucoma patients. One research looked at best-corrected visual acuity (BCVA) in 213 eyes of 213 glaucoma patients and showed a substantial correlation between glaucoma severity and visual acuity degradation [16].

The thickness of the fovea and the superior inner macula did not vary significantly . the two groups in our research (P = 0.248 and P = 0.326, respectively). Several other parts of the macula, however, showed statistically significant variation. Thicker maculae are associated with better vision, and the group had thinner maculae in the inferior inner (P = 0.031*), temporal inner (P = 0.001*), nasal inner (P = 0.003*), inferior outer (P 0.001*), temporal outer (P 0.001*), and superior outer (P 0.001*) regions. The nasal outer macula showed no statistically significant differences (P = 0.2196).

Foveal was not significantly different in individuals with compared to healthy controls, which is consistent with a research by Sánchez-Pulgarn et al. [17]. The superior inner macula of both groups was found to be similar in a by Chaturvedi et al. [18].

Several other parts of the macula, however, showed statistically significant variation. Thinner tissue was seen in patients compared to controls in two investigations [19, 20].

When comparing the two groups, however, the nasal outer macula showed no discernible variation (P = 0.2196). Similar results were reported by Ilhan and Citirik [21], who found no statistically significant difference in nasal outer macula in patients and controls.

Several assessments of were significantly different in the two groups .

Several more research on patients corroborate these results. Consistent with our findings, Vizzeri et al. [22] found that all four quadrants of the (superior, inferior, temporal, and lateral) were significantly thinner. Measurements of in the superior and inferior quadrants of patients were shown to be significantly different by Liu et al. [23].In contrast, our results corroborate the findings of [18], which found no significant differences the nasal quadrant and individual segments of the . This includes segments 1, 3, 5, 6, 9, 11, and 12. Similarly, the researchers found no statistically significant changes patients and controls in these areas.

Average of the nerve fibre layer in relation to glaucoma stage and degree of damage: Our results are consistent with those of other research that measured at phases. Similarly, Grewal et al. found that the gradually thins down in later stages of glaucoma. The researchers discovered that the average decreased with increasing disease severity, lending credence to the idea that the thins with time in glaucomatous eyes[24].

In addition, Geng et al. did an analogous , and they also found substantial thinning in varying degrees of . Our findings are comparable with theirs, which showed a steady decrease in average from early to moderate and severe stages of the illness [25].

Our results showed that in the 7 o'clock sector was most strongly correlated with that in the inferior inner area (r = 0.637, p 0.001).

Consistent with our findings, Sánchez-Pulgarn et al. [17] found that the 7 o'clock sector and the inferior inner area had the highest link p and age (r = 0.632; P 0.001).

However, in their cohort of glaucoma patients, Christopher et al. observed no significant association and characteristics. According to their research, glaucoma may cause structural alterations in both the and regions separately. Possible explanations for this mismatch include variations in designs, patient populations, and statistical analyses.

The present demonstrated a significant connection in the inferior inner area and the temporal inferior 8 o'clock position (r = 0.704, p = 0.006) among individuals with early .

Intriguingly, Sánchez-Pulgarn et al. [17] found that the p at 8 o'clock (temporal inferior in one right eye) was most strongly correlated with the inferior inner area (r = 0.702; P 0.001).

It should be noted, however, that not all research have produced similarly consistent findings. was not shown to correlate with throughout disease stages in a of 60 individuals with [27]. However, Kim et al. showed that the relationships and changed with disease stage in a separate group of 52 patients [28].

Differences in research demographics, sample sizes, equipment utilised, and methods of analysis might account for these contrasting results. It's also possible that variations in the criteria used to determine illness stages and the precise parameters assessed are to blame for the discrepancies across studies.

The 10 o'clock was shown to have the highest association with the superior inner macula in the moderate group (r = 0.588, p = 0.01). The superior outer macula and the 4 o'clock were shown to be most correlated in advanced glaucomas (r = 0.581, p 0.001).In line with this, Sánchez-Pulgarn et al. found that associations were less in the mild and advanced glaucoma groupings. The p at 10 o'clock was found to have the strongest correlation with the superior inner macula in the moderate group (r = 0.580; P 0.001), while the p at 4 o'clock was found to have the strongest correlation with the superior outer macula in the advanced glaucomas (r = 0.575; P 0.001). [17].

Patients with early showed a link p in the inferior inner area (r = 0.702) and the 8 o'clock position (temporal inferior in one right eye). Among those with mild and advanced glaucoma, associations were weaker. The p at 10 o'clock was most correlated with the superior inner macula in those with intermediate (r = 0.580), whereas at 4 o'clock it was most correlated with the superior outer macula in those with advanced glaucomas (r = 0.575). The fact that the nasal quadrant of p is only impacted in the latter stages of the illness may account, at least in part, for this final association [29].

Manually defining each layer of the retina allowed Ishikawa et al. and Tan et al. to specifically the layers of the retina that are impaired in glaucoma. assessments [30, 31] found that the outer layers were unaltered but the inner layers exhibited considerable thinning. This difference in was shown to have discriminant power similar to that of .

Patients with glaucoma showed significant thinning of the entire macula, the ganglion cell complex, and the nerve fibre layer () when analysed with Topcon 3D-, but the of the ganglion cell complex in the inferior temporal outer sector was the most useful variable (area under the ROC curve 0.86; reference 32).

Conclusions

In conclusion, our research found statistically significant variations in the controls and patients at varying stages of POAG. These variations were seen in both macula and RNFL, suggesting that measures may be useful as a diagnostic tool for POAG. The research also revealed a wide range of accuracy when it came to predicting stages of POAG.

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