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Original Article

RETINAL VASCULAR CHANGES AND VISUAL FIELD PARAMETERS IN PRIMARY OPEN ANGLE GLAUCOMA PATIENTS.

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Abstract

Background: *Primary Open Angle Glaucoma (POAG) is a prevalent neurodegenerative disorder marked by the progressive degeneration of the retinal nerve fiber layer (RNFL) and retinal ganglion cells (RGCs), attributable to ischemia. The non-invasive optical coherence tomography angiography (OCTA) method provides a new way to diagnose and treat glaucoma by detecting and quantifying vascular and clinical structural characteristics. In regard to glaucoma staging system II visual field, this research intends to identify ischemia alterations in primary open-angle glaucoma patients using optical coherence tomography (OCT) angiography.* ***Patients and methods:*** *Group A consisted of 40 eyes from 40 glaucomatous patients, while Group B consisted of 40 eyes from 40 healthy, non-glaucomatous volunteers in this prospective observational single-center hospital-based cross-sectional case-control clinical trial. Visual acuity, intraocular pressure, gonioscopy, optical coherence angiography, visual field, and data were gathered and evaluated from all subjects.* ***Results****: Each group is balanced in terms of age and gender. In terms of mean UDVA and CDVA, there were highly significant differences between the two groups (P-value <0.001). Mean intraocular pressure (IOP) did not differ significantly between the two groups (13.59 ± 2.11 and 15.08± 0.67, respectively; P-value = 0.06). For both the superior and inferior RNFL thickness, there was a highly significant difference between the cases and controls according to optical coherence tomography assessment (OCT) (P-value = 0.002 and 0.001, respectively), in relation to OCTA.A statistically significant difference was seen with respect to the whole picture, the upper hemifield, and the lower hemifield VD (P-value <0.001 for all components). There were robust positive associations found between one set of MD visual field measurements and a number of OCT and OCTA outcome metrics, notably the OCT inferior RNFL thickness. However, considerable negative associations were seen between PSD in the visual field and both the superior and inferior RNFL thickness in the OCT (r=0.21, 0.68; P-value = 0.005 and 0.003, respectively).* ***Conclusion:*** *In patients with POAG, a higher negative MD and higher positive PSD values in the VF are associated with thinner RNFL thickness, larger OCTA FAZ size and perim, lower retinal perfused vessel density, and reduced retinal blood flow, all of which point to the presence of ischemic retinal changes.*

Keywords: *Primary open angle glaucoma, Visual field, Optical coherence tomography angiography, Agreements.*

1. Introduction

One prevalent neurodegenerative illness is primary open angle glaucoma (POAG), which is marked by the progressive and selective loss of retinal ganglion cells

(RGCs) and the retinal nerve fiber layer (RNFL) [1]. Although aging and elevated intraocular pressures (IOP) are known to increase the risk of glaucoma, the fact that individuals worsen regardless of IOP level suggests the presence of other variables [2]. The primary cause of optic nerve injury in glaucomatous eye disease is increased intraocular pressure (IOP). One theory is that when intraocular pressure (IOP) rises, the lamina cribrosa (LC) deforms and compresses mechanically, which in turn causes pinching and kinking of the retinal ganglion cell (RGC) axons as they pass through the laminar pores, which either promotes or initiates the blockage of axonal flow and, ultimately, axonal injury in glaucoma [3]. POAG is a main cause of permanent blindness and a big global health problem because to its silent and progressive nature [4]. It is often possible to detect glaucoma and stop its progression before it causes major visual impairments with the help of proper screening and treatment. Diagnosis and therapy rely on anatomical and functional examination and monitoring of the optic nerve head and the Retinal Nerve Fiber Layer (RNFL) [5]. Loss of visual field sensitivity is clinically associated with optic nerve injury and loss of nerve fiber layers. As primary open-angle glaucoma develops naturally, the retina loses ganglion cells and the axons that carry vision. Osteocortex might be used to assess the brain damage [6,7]. Another non-invasive technique that may identify and measure clinical structural and vascular factors, providing a new way to diagnose and treat glaucoma, is optical coherence tomography angiography (OCTA). Since OCTA did not reveal a measurement floor, it might be a useful tool for tracking the development of advanced glaucoma, much like OCT [8]. The aim of this study is to detect ischemic changes in the macula using OCT angiography in primary open-angle glaucoma patients in correlation with glaucoma staging system II by visual field.

2. Patients and Methods

This study was designed as a prospective observational single-center hospital-based cross-sectional case-control clinical trial that gained the approval of the Medical Research Ethics Committee in the Faculty of Medicine, Sohag University, Egypt (ID: Soh-Med-22-03-03). In addition, our research adhered to the principles of the Declaration of Helsinki and got the clinical trial registration number (ID NCT053 51307) from the website of Clinical Trials. gov. The experiment was place from May to November 2023 at Sohag University, Egypt's Department of Ophthalmology, Faculty of Medicine.

2.1. *Grouping and eligibility criteria*

Our study included 80 eyes of 80 participants who were divided into two groups: A & B groups which included age-matched and sex-matched participants. *Group A:* (glaucomatous group/ observational group/ cases) included 40 eyes of 40 glaucomatous patients, While **Group B** (non-glaucomatous group/ control group/ controls) included 40 eyes of 40 normal healthy non-glaucomatous volunteers. A coin toss was used to include the right or the left eye for each study participant.

2.2. *Inclusion criteria*

In group A, which is the glaucomatous group or cases, we included individuals who met the following criteria: they had to be at least 40 years old, have uncorrected distance visual acuity (UDVA) of 1.30 logarithm of the minimum angle of resolution (logMAR) or better, corrected distance visual acuity (CDVA) of 1.00 logMAR or better, subjective refraction of ±2 D, intraocular pressure (IOP) of 16

mmHg or less, which was controlled with one or two topical anti-glaucoma eye drops, and an open angle of the anterior chamber seen by gonioscopy.

2.3. *Exclusion criteria*

In group A were: other concomitant eye pathology or disease and previous eye or systemic operations. We used three glaucoma classification systems in this study: Glaucoma staging system 2 (GSS 2) which depends on the visual field to document the functional damage; OCT glaucoma staging system that depends on RNFL Analysis to document the structural damage and the Global Glaucoma Staging System (GGSS) combining both functional and structural damage. Therefore, we designed a special sheet for recording the previous stages in each glaucomatous patient. Group B, which consisted of non-glaucomatous individuals and served as controls, was defined as follows: age of 40 years or older, UDVA of 0.30 logMAR or higher, and CDVA of 0.00 logMAR or higher, subjective refraction ±2 diopter (D), within normal slit-lamp, pupillary and fundus examinations; IOP ≤16 mmHg and an open angle of the anterior chamber detected by gonioscopy. Meanwhile, the exclusion criteria in group B were: concomitant eye pathology or disease, previous eye or systemic operations, and positive family history of glaucoma.

2.4. *Examinations and procedures*

The eye tests that all the subjects in the research went through were slit-lamp and fundus exams, as well as UDVA and CDVA, subjective refraction, intraocular pressure measurement using a Goldmann applanation tonometer, and pupillary reflexes. Additionally, macular OCTA, optical coherence tomography (OCT) of the nerve head, and visual field assessments were performed on all individuals. Our main metrics for successful outcomes were VF Pattern Standard Deviation (PSD), VF Mean Deviation (MD), OCT RNFL thickness (in both the upper and lower quadrants), OCTA results (in both the macular and foveal Vessel Density, or VD), and Foveal Avascular Zone (FAZ) parameters. At the same time, we measured intraocular pressure (IOP), cup-disc ratio (C/D ratio), UDVA, and CDVA as secondary outcomes. The devices used in this study were Goldmann applanation tonometer (AT 900, HAAG-STREIT Diagnostics, Koeniz, Switzerland), visual perimeter (OCULUS Centerfield® 2, OCU LUS®, Wetzlar, Germany), and ophthalmic OCT system (Avanti Scanner, Optovue, Inc., Hannover, Germany). Lastly, for statistical analysis, all participant data was filled out in Excel sheets. Due to the nature of the research being a cross-sectional trial, no follow-up visits were conducted with the individuals who were first evaluated and studied. It was advised that all patients with glaucoma keep coming to the Out-Patient Glaucoma Clinic (OPGC) for their follow-up appointments.

3. Results

3.1. *Statistical analysis*

Quantitative variables were expressed as means and standard deviation for normally distributed data and as median and range (minimum–maximum) for not normally distributed data. The normality of data distribution was tested using the Kolmogrov-Sminrov test. The qualitative variables were expressed as percentages of occurrence. To compare the cases and controls by age group, the Mann-Whitney U test was used, visual acuity assessment (UNVA and CDVA), IOP, Fundus examination, Visual field assessment using glaucoma staging system Ⅱ, Optical coherence tomography (OCT) parameters (Superior and inferior), Optical coherence tomography angiog-

raphy (OCTA) of vessel density (VD) of whole image parameters, OCTA of vessel density of fovea and parafoveal assessment and OCTA of foveal avascular zone assessment (P value was significant if ≤ 0.05). Chi-square test was used to compare cases and controls according to sex (P value was significant if ≤ 0.05). Spearman correlation coefficient was calculated between Visual field (VF) severity indices and OCT parameters. The value of the test is expressed as r, values are interpreted as follows: ***)** A positive value indicated direct proportion. ***)** Negative values indicated an inverse correlation. ***)** R from (0: 0.3) or (0:-0.3) indicated a weak correlation. ***)** R from (0.3:0.6) or (-0.3:-0.6) indicated a moderate correlation. ***)** R from (0.6:1) or (-0.6:-1) indicates strong correlation.

3.2. *Characteristics of the study population*

The mean ages and sexes of the cases and controls groups were not significantly different from one another (P-value= 0.14 and 0.49, respectively). The study population's characteristics are shown in tab. (1).

Table 1: Characteristics of the study population

Variable	Group A (cases) (n=40)	Group B (controls) (n=40)	Total (n=80)	P-value
Age (years)				
Mean ± SD	58.75 ± 8.44	61.8 ± 7.87	60.28 ± 8.25	**0.14***
Range	(32 – 70)	(46 – 77)	(32 – 77)	
Sex				
▪ ***Male***	24 (60%)	21 (52.5%)	45 (56.2%)	**0.49 ****
▪ ***Female***	16 (40%)	19 (47.5%)	35 (43.8%)	

**** P-value** is calculated by the Mann-Whitney test; **** P-value** is calculated by Chi-square test*

3.3. *Visual outcomes*

Differences in mean UDVA and CDVA were found to be extremely significant (P<0.001) in both groups, with group A (cases) showing greater values and group B (controls) showing lower values.

3.4. *Intra-ocular pressure outcomes*

Both groups' mean intraocular pressure (IOP) measurements were similar (14.59 ± 2.11 and 15.08± 0.67, respectively; P-value = 0.06), suggesting that there were no statistically significant differences. Table (2) shows the visual outcomes and intraocular pressure outcomes of the study population**.**

Table 2: Visual acuity outcomes and IOP outcomes in both groups

Variable	Group A (cases) (n=40)	Group B (controls) (n=40)	P-value *
UDVA (logMAR)			
▪ ***Mean ± SD***	0.73 ± 0.39	0.27 ± 0.07	< 0.001
▪ ***Median***	0.5	0.3	
▪ ***Range***	(0 – 1.3)	(0 - 0.5)	
CDVA (logMAR)			
▪ ***Mean ± SD***	0.36 ± 0.19	0.08 ± 0.05	< 0.001
▪ ***Median***	0.35	0.1	
▪ ***Range***	(0 – 1)	(0 – 0.1)	
IOP (mmHg)			
▪ ***Mean ± SD***	14.59 ± 2.11	15.08± 0.67	0.06
▪ ***Median***	14	15	
▪ ***Range***	(10 – 16)	(12 – 16)	

**** P-value** is calculated by Mann-Whitney; **A: UDVA**, uncorrected distance visual acuity; **CDVA**, corrected distance visual acuity; **logMAR**, logarithm of the minimum angle of resolution; **SD**, standard deviation; **IOP**, Intraocular pressure; **mmHg**, millimeter of mercury.*

3.5. *Cup–disc ratio outcomes*

There was a significant difference (P-value <0.001) in the mean cup disc ratio between the patients and controls when it came to the fundus examination. The cases had a ratio of 0.6 ± 0.17, while the controls had a ratio of 0.25 ± 0.05. Results for the study's participants are shown in tab. (3). for the cup disc ratio.

Table 3: Cup/disc ratio outcomes in both groups

Variable	Group A (cases) (n=40)	Group B (controls) (n=40)	P-value *
C/D ratio			
▪ ***Mean ± SD***	0.6 ± 0.17	0.25 ± 0.05	<0.001
▪ ***Median***	0.6	0.3	
▪ ***Range***	(0.3 – 0.9)	(0.2 – 0.3)	

**** P-value** is calculated by Mann-Whitney; **C/D ratio**, cup–disc ratio; **SD**, standard deviation.*

3.6. *Visual field outcomes*

In relation to the MD, both groups showed a very significant statistical difference (P-value <0.001). The mean mean decibel (dB) for patients was -9.87 ± 4.36 while for controls it was -1.32 ± 0.21. Both groups showed a very significant statistical difference (P-value <0.001) in relation to PSD. Cases had an average PSD of 6.18 ± 1.76 dB, whereas controls had an average of 2.8 ± 0.59 dB. The visual field results of the research subjects are shown in tab. (4).

Table 4: VF outcomes using glaucoma staging system Ⅱ in both groups

Variable	Group A (cases) (n=40)	Group B (controls) (n=40)	P-value *
MD (dB)			
Mean ± SD	-9.87 ± 4.36	-1.32 ± 0.21	< 0.001
Median	-11.5	-1.4	
Range	(-18.6: -3.59)	(-1.8:-0.7)	
PSD (dB)			
Mean ± SD	6.18 ± 1.76	2.8 ± 0.59	< 0.001
Median	6.4	2.55	
Range	(2.76: 9.1)	(2.12: 3.9)	

**** P-value** is calculated by Mann-Whitney; **VF**, visual field; **MD**, Mean deviation; **PSD**, Pattern standard deviation; **dB**, decibels; **SD**, standard deviation.*

3.7. *OCT outcomes*

Optical coherence tomography (OCT) evaluation of superior RNFL thickness (P= 0.002) and inferior RNFL thickness (P= 0.001) showed a highly statistically significant difference between the patients and controls, respectively. Both mean superior and inferior RNFL thicknesses revealed statistically significant thinning in A versus B groups (93.3 ± 25.07 versus 110.48 ± 6.04 µm; and 99.05 ± 25.37 versus 116.75 ± 5.3; respectively). Comparing ganglion cell complex showed that cases group has a significantly lower measure of ganglion cell complex in comparison to controls (89.03 ± 9.18 and 118 ± 3.42). Table (5) shows the OCT outcomes and comparison of ganglion cell complex of study participants.

Table 5: OCT optic nerve head and comparison of ganglion cell complex in both groups

Variable	Group A (cases) (n=40)	Group B (controls) (n=40)	P-value*
Superior RNFL thickness (µm)			
▪ ***Mean ± SD***	93.3 ± 25.07	110.48 ± 6.04	0.002
▪ ***Median***	94	110	
▪ ***Range***	(55 – 137)	(102 – 121)	

Inferior RNFL thickness (µm)			
▪ ***Mean ± SD***	99.05 25.37	116.75 ± 5.3	0.001
▪ ***Median***	99.5	115.5	
▪ ***Range***	(60 – 138)	(108 – 126)	
Variable	**Cases (n = 40)**	**Controls (n = 40)**	**P-value ***
Ganglion cell complex (µm)			
▪ ***Mean ± SD***	89.03 ± 9.18	118 ± 3.42	< 0.001
▪ ***Median***	86	118	
▪ ***Range***	(77-105)	(110-125)	

**** P-value** is calculated by Mann-Whitney; **RNFL**, retinal nerve fiber layer; µm, micrometer; **SD**, standard deviation*

3.8. *OCTA outcomes*

3.8.1. OCTA outcomes of the whole image VD (vessel density)

A statistically significant difference was seen with respect to the whole picture, the upper hemifield, and the lower hemifield VD (P-value <0.001 for all components). In terms of mean whole image vessel density, the control group had a greater value (50.19 ± 0.59) compared to the case group (42.49 ± 5.64).

3.8.2. OCTA outcomes of foveal and parafoveal VD

There was a very significant difference between the patients and controls when the visual depth (VD) of the foveal, superior hemifield of the parafovea, inferior hemifield of the parafovea, and nasal hemifield of the parafovea were compared (P-value <0.001, 0.01, 0.02, 0.001; respectively). Compared to controls, patients had a reduced mean perfused VD in the foveal area (9.62 ± 6.5 percent vs. 19.48 ± 4.18 percent). Nevertheless, when comparing the research participants based on perfused visual d'orientation (VD) in the parafoveal area and the temporal hemifield of the parafoveal, there was no statistically significant difference (P-value= 0.93 and 0.23 %, respectively).

3.8.3. FAZ outcomes

According to the statistics, the flow density of the FAZ was not different (P-value= 0.95), but the size and circumference of the FAZ were significantly different (P-value <0.001 for all individuals in the study). In cases, the average FAZ size was 0.41 ± 0.06 mm², whereas in controls, it was 0.18 ± 0.008 mm². In addition, the average FAZ perim for the patients was greater than the controls' (2.6 ± 0.24 mm vs. 1.8 ± 0.1 mm). Table (6) shows the OCTA outcomes of the study participants.

Table 6: OCTA mean macular VD, foveal and parafoveal VD, and FAZ mean outcomes in both groups

Variable	**Group A (cases) (n=40)**	**Group B (controls) (n=40)**	**P-value***
The whole image (VD; %)			
▪ ***Mean ± SD***	42.49 ± 5.64	50.19 ± 0.59	< 0.001
▪ ***Median***	43.9	50.15	
▪ ***Range***	(32.2 – 50.6)	(49.4 – 51.9)	
Superior hemifield (VD; %)			
▪ ***Mean ± SD***	42.4 ± 5.8	48.96 ± 0.96	< 0.001
▪ ***Median***	43	49.25	
▪ ***Range***	(30.2 – 53.4)	(46 – 50.2)	
Inferior hemifield (VD; %)			
▪ ***Mean ± SD***	41.41 ± 5.79	50.79 ± 0.56	< 0.001
▪ ***Median***	42.1	50.7	
▪ ***Range***	(30.5 – 51.2)	(50.1 – 51.9)	
Foveal (VD; %)			
▪ ***Mean ± SD***	9.62 ± 6.5	19.48 ± 4.18	< 0.001
▪ ***Median***	8.4	20.35	
▪ ***Range***	(2.7 – 30.7)	(10.4 – 25.1)	

Parafoveal (VD; %)			
▪ ***Mean ± SD***	44.9 ± 7.93	47.59 ± 2.44	0.93
▪ ***Median***	48.3	47.35	
▪ ***Range***	(31.1 – 55.6)	(42.8 – 52)	
Temporal hemifield parafoveal (VD; %)			
▪ ***Mean ± SD***	44.45 ± 9.66	48.66 ± 3.03	0.23
▪ ***Median***	48	48.9	
▪ ***Range***	(24 – 55.8)	(43.5 – 55)	
Superior hemifield parafoveal (VD; %)			
▪ ***Mean ± SD***	45.97 ± 7.51	50.24 ± 2.53	0.01
▪ ***Median***	48.5	50.4	
▪ ***Range***	(25.9 – 55)	(38.4 – 54.3)	
Nasal hemifield parafoveal (VD; %)			
▪ ***Mean ± SD***	42.76 ± 9.28	47.6 ± 2.98	0.02
▪ ***Median***	46.8	48.4	
▪ ***Range***	(26.4 – 57.6)	(42.3 – 52.4)	
Inferior hemifield parafoveal (VD; %)			
▪ ***Mean ± SD***	45.48 ± 8.63	53.01 ± 3.27	< 0.001
▪ ***Median***	48.85	53.3	
▪ ***Range***	(29.3 – 56.7)	(45.5 – 59.5)	
FAZ size (mm^2)			
▪ ***Mean ± SD***	0.41 ± 0.06	0.18 ± 0.008	< 0.001
▪ ***Median***	0.41	0.18	
▪ ***Range***	(0.31 – 0.57)	(0.16 – 0.19)	
FAZ perim (mm)			
▪ ***Mean ± SD***	2.6 ± 0.24	1.8 ± 0.1	< 0.001
▪ ***Median***	2.54	1.81	
▪ ***Range***	(2.24 – 3.23)	(1.54 – 1.98)	
FAZ flow density (%)			
▪ ***Mean ± SD***	45.76 ± 11.39	48.9 ± 5.18	0.95
▪ ***Median***	49.85	50.1	
▪ ***Range***	(15.37 – 57.42)	(32.81 – 56.6)	

**** P-value** is calculated by Mann-Whitney; **OCTA**, optical coherence tomography angiography; **VD**, vessel density; foveal avascular zone; **SD**, standard deviation.*

3.9. *Results of glaucoma staging*

in group A (glaucomatous patients), our GGSS outcomes revealed that: ***)** 6 (15%) patients were classified as stage 1 (early functional and structural damage), ***)**15 (37.5%) patients were classified as stage 2 (mild functional and structural damage), ***)**17 (42.5%) patients were classified as stage 3 (moderate functional and structural damage) and 2 (5%) patients were classified as stage 4 (advanced functional and structural damage).

3.10. *Study correlations*

3.10.1. MD correlations

The multiple-angle visual field MD and multiple-outcome measurements from optical coherence tomography and optical coherence tomography all showed strong positive relationships. These included the OCT inferior RNFL thickness, the OCTA macular vessel density (including the whole image, superior and inferior hemifields), and the OCTA foveal and parafoveal vessel density (including the parafoveal region, the temporal, superior, nasal, and inferior parafoveal hemifields; with a p-value of less than 0.001 for all). Despite this, we did not see any associations between MD and the OCTA FAZ (all with a p-value of ≥0.05). Correlations between MD variables are shown in tab. (6). Our investigation also revealed a connection between the negative MD value and these favorable associations. What this means

is that the OCTA vessel density in the macula, fovea, and parafoveal hemifields decreases as the negativity (minus sign) of MD in the visual field increases, leading to a lower MD value. In addition, the greater the negative sign of MD in the visual field, which in turn lowers the MD value, the narrower the OCT inferior RNFL will be.

3.10.2. PSD correlations

But there were strong negative correlations between PSD in the visual field and the upper and lower RNFL thickness in the optical coherence tomography (r= 0.21, 0.68; P-value= 0.005 and 0.003, respectively). To restate, the visual field PSD value increases as the OCT's superior and inferior RNFL shrink. In addition, we found that the parafoveal nasal hemifield of OCTA was negatively correlated with PSD. To rephrase, the parafoveal nasal hemifield OCTA vascular density decreases as the visual field PSD value increases. The associations are shown in tab. (7). Alternatively, we found rather robust positive associations between visual field PSD and OCTA FAZ size and perim (r= 0.37 and 0.49, P-value = 0.01), meaning that larger OCTA FAZs and perims were associated with higher PSD values, figs. (1 & 2)

Table7: Correlations between VF, OCT, and OCTA outcome measures

OCT parameters	MD		PSD	
	r value	P-value^	r value	P-value^
OCT assessment of peripapillary RNFL thickness				
Superior RNFL thickness	0.21	0.17	-0.43	0.005
Inferior RNFL thickness	0.68	<0.001	-0.45	0.003
OCTA assessment of perfused vessel density of the macula				
The whole image	0.56	<0.001	-0.22	0.16
Superior hemifield	0.58	<0.001	-0.31	0.05
Inferior hemifield	0.69	<0.001	-0.23	0.14
OCTA assessment of retinal perfused of foveal and parafoveal				
Foveal region	0.07	0.66	-0.3	0.05
Parafoveal region	0.62	<0.001	-0.3	0.05
Temporal hemifield of parafoveal	0.61	<0.001	-0.18	0.24
Superior hemifield of parafoveal	0.58	<0.001	-0.29	0.06
Nasal hemifield of parafoveal	0.58	<0.001	-0.41	0.008
Inferior hemifield of parafoveal	0.57	<0.001	-0.18	0.25
OCTA assessment of foveal avascular zone				
FAZ size	0.2	0.2	0.37	0.01
FAZ perim	0.1	0.52	0.49	0.001
FAZ flow density	0.3	0.05	0.03	0.85

**** P-value** is calculated by Mann-Whitney; **VF**, visual field; **OCT**, optical coherence tomography; **OCTA**, optical coherence tomography angiography; **MD**, Mean deviation; **PSD**, Pattern standard deviation; **SD**, standard deviation.*

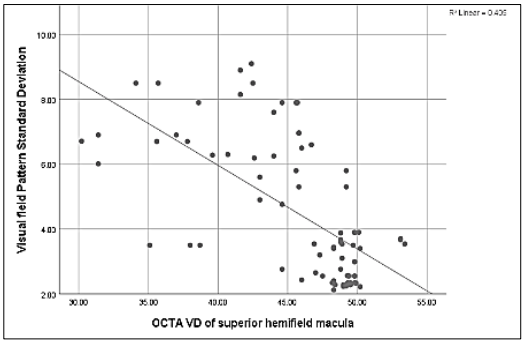

Figure 1: shows the relation between OCTA VD of superior hemifield of macula and PSD of the visual field of the studied participants.

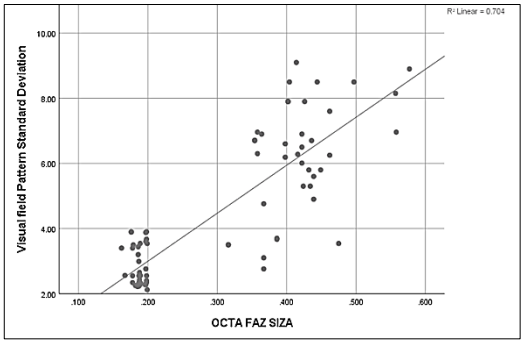

Figure 2: Relation between OCTA FAZ size and PSD of the visual field of the studied participants.

4. Discussion

Statistically significant differences in RNFL across the upper and lower hemifields are concerning indicators of glaucomatous damage, and there have been few investigations comparing glaucomatous patients with normal. RNFL thinning progresses over time in POAG patients. Vascular distribution may explain why the two hemifields are more affectionate. Glaucoma symptoms and indicators worsen in relation to the severity of ischemia alterations and the affection between the RNFL and the eye [9,10]. This research confirmed that GCC thickens with time; OCTA evaluation of ischemic alterations revealed parafoveal microvascular weakening and FAZ widening [11]. Ischemic alterations cause greater ganglion cell death as the thickness of the GCC decreases, which in turn causes more visual impairment. The ischemic alterations experienced by glaucoma patients may be described by the loss in vasculature in all four quadrants, which is also evident in the changes in vascular density and the difference between the disease and controls. The root of the disease lies in ischemic alterations, which cause ganglion cells to die and lose their layer of retinal nerve fibers. The vascular density is impacted in all glaucoma patients, lending credence to the concept that glaucomatous damage is caused by vascular insufficiency, either by increased intraocular pressure (IOP) or by reduced perfusion [12]. The present research demonstrated a very significant positive relationship (P-value ≤0.05) between MD and OCT evaluation of peripapillary RNFL inferior hemifield thickness. In addition, the thickness of the RNFL's superior and inferior hemifields was significantly correlated with PSD (P-value ≤0.05), suggesting that VF characteristics might be used to predict the degree of vascular affection, and vice versa. One way to get a feel for the retina's vascular health is to measure visual field characteristics, and the other way around. The ability to forecast field changes using RNFL thickness has been shown in the past [13]. Although the visual field (VF) is a subjective instrument, its accuracy has to be confirmed before it can be used as a prediction factor for vascular alterations.

5. Conclusion

In patients with POAG, a higher negative MD and higher positive PSD values in the VF are associated with thinner RNFL thickness, larger OCTA FAZ size and perim, lower retinal perfused vessel density, and reduced retinal blood flow, all of which point to the presence of ischemic retinal changes.

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