Correlation Between Contrast Sensitivity and Retinal Nerve Fiber Layer Thickness in Patients with Primary Open-Angle Glaucoma

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Short title: Correlation Between Contrast Sensitivity and Retinal Nerve Fiber Layer Thickness

Abstract

Purpose: The current study aimed to assess contrast sensitivity and retinal nerve fiber layer (RNFL) thickness in patients with primary open-angle glaucoma (POAG) and to evaluate their correlations.

Patients and Methods: This was a cross-sectional observational analytical study conducted on a total of 195 eyes included 95 eyes of 55 patients with POAG and 100 healthy control (HC) eyes of 50 subjects. The glaucomatous eyes were divided into three groups (mild, moderate and sever). Most of studied cases were mild (41.1%), while moderate and sever degrees were recorded in (26.3%) and (32.6%) of cases respectively. Contrast Sensitivity Assessment was done by The Pelli Robson Test and Oculus Mesotest II.

Results: The mean age of patients with POAG was (57.89±8.49) years, while in the control group it was (55.59±10.37) years. There were statistically significant differences between the two groups as regards BCVA and IOP. POAG groups were associated with highly significant increase in Cup/disc ratio (CDR) and highly significant decrease in the mean deviation compared to control group. There was a statistically significant decrease in contrast sensitivity and highly statistically significant decrease in RNFL thickness in patients' group in comparison with control group. There were highly statistically significant positive correlations between contrast sensitivity assessment and all RNFL parameters.

Conclusion: Contrast sensitivity has been correlated with RNFL thickness in POAG patients. Contrast sensitivity and RNFL thickness play an important role in detection of POAG.

Keywords: Intraocular pressure, Nerve fiber layer, Optical coherence tomography, Visual acuity, Primary open angle glaucoma, Contrast sensitivity.

INTRODUCTION

Glaucoma is a group of diseases which is featured by optic neuropathy with excavation and undermining of the neural and connective tissue components of optic disc which results in development of characteristic patterns of visual impairment eventually[1]. Glaucoma is characterized by high intraocular pressure (IOP) in the eye and can lead to vision loss[2].

World health organization (WHO) measured blindness prevalence for all glaucoma types as > 37 million persons, placing it as the 2nd major reason of visual loss globally, that formerly was measured to be 3rd cause of blindness, which primarily affects older people[1].

Adult glaucoma is classified into two groups: open-angle and angle-closure glaucoma, each type may be primary or secondary[3]. Primary open-angle glaucoma (POAG) is a chronic, progressive and irreversible multifactorial optic neuropathy in which there is an acquired optic nerve atrophy and loss of retinal ganglion cells (RGCs) and their axons. POAG is linked to a gonioscopy-detected open anterior chamber angle (ACA), characteristic abnormalities in the optic nerve head (ONH), and a notable loss of peripheral vision, for which an essential and adjustable risk factor is IOP. POAG is

typically asymmetric but is frequently bilateral. POAG is a potentially blinding ocular disorder, however early diagnosis and proper management could prevent visual dysfunction and improve quality of life (QoL)[4].

Many glaucoma cases are not aware that they have the disease until it is found during a regular eye checkup, especially early on in the illness's course. Until the illness process is severe, people usually gradually lose their peripheral vision while maintaining their center vision. On Humphrey visual field (VF) testing, this may appear as a characteristic arcuate pattern[5].

Contrast sensitivity is a crucial component of vision. Specifically, it plays a part in motion detection, visual acuity (VA), pattern recognition, dark adaptation, and visual function. Patients' QoL is impacted by CS. It is the capability of detecting subtle differences in shading and patterns[6]. RNFL is primarily affected in glaucoma. Optical coherence tomography (OCT) provides an extremely objective assessment of optic nerve, RNFL, and macula. In comparison to conventional automated perimetry, that is a subjective test with more variability[1]. In glaucoma patients, RNFL loss occurs prior to ONH abnormalities and VF loss (VFL). The perimacular area of the eye has the thickest ganglion cell layer (GCL), in glaucomatous eyes, this GCL is thinning. RNFL gradually thins as glaucoma worsens, causin g a corresponding loss of visual field of affected eye[7].

Contrast sensitivity and VA are the two main indicators of human visual function that are associated with the retinal tissue that contains the retinal GCL and its axons (RNFL). Notably, it is well known that the center and surrounding structure of the RGC receptive fields encode contrast information immediately, being the first area where the photoreceptor impulses are translated into neural activity[8]. The close correlations between QoL scores, structural and functional measurements had lighted its importance in glaucoma[9]. Therefore, the purpose of this study was to assess the relationship between RNFL thickness and contrast sensitivity in individuals with POAG.

PATIENTS AND METHODS

Study Design

This an observational, analytical, and prospective study conducted from April 2020 till September 2022 at Mansoura ophthalmic center, Mansoura University, Egypt.

Ethics and Consent

The current study was submitted for approval by IRB of Faculty of Medicine at Mansoura University before starting the study on 29 October 2019 (code number MS.19.10.871). All individuals singed a written informed consent before study contribution. The 1964 Declaration of Helsinki and its later amendments or equivalent ethical standards were followed during study.

PATIENTS

This research included 195 eyes of 105 patients that were divided into patients group that included 95 eyes of 55 individuals with POAG and control group that included 100 healthy control eyes of 50 subjects.

This study comprised cases with POAG aged above 40 years, both genders, best corrected visual acuity (BCVA) ≥ 6/60, refractive error within ±3.0 diopters spherical equivelant and within ±3.0 diopters astigmatism, or less than 2.0 diopter anisometropia, open ACA by gonioscopy, evidence of glaucomatous optic nerve head damage (such as neuroretinal rim thinning, notching, excavation, or RNFL defects) and glaucomatous pattern of VFL on Humphrey 24-2 VF test.

The control group consisted of individuals over 40 years old, had no family history of glaucoma, had no history or signs of eye disease, surgeries, had an IOP of 21mmHg or less by Goldmann applanation tonometry, had a normal shape of optic nerve head and a normal VF, had the BCVA of at least 6/60.

Patients excluded were angle closure glaucoma, prior intraocular surgery or laser therapy, cataracts and hazy media that can reduce contrast sensitivity, unreliable VF tests, trauma, inflammation, or previous ocular infections, corneal pathology, neurological disorders that cause VF defect mimicking glaucomatous changes, and IOP uncontrolled on medical medication..

Ocular Examination

The ophthalmologic examination included assessment of BCVA by landolts broken ring chart and after that converted to log MAR, examination of anterior segment using slit lamb

biomicroscopy (Haag streit BP 900), gonioscopy to examine anterior chamber angle, measurement of IOP by Goldman applanation tonometry, fundus examination using slit lamb (SL) biomicroscopy and volk lens 90 diopters.

In addition, VF was assessed by Oculus twin field. Assessment of RNFL thickness was performed by utilizing spectral-domain OCT (SD-OCT), (Topcon Corporation, Tokyo, Japan).

Visual field (VF) assessment

Patients were tested with undilated pupils using static automated white on white 24-2 stimulus presentation pattern and full threshold strategy. All tests were conducted by utilizing Swedish Interactive Threshold Algorithm (SITA) standard strategy.

Hoddap Parrish Anderson criteria

The following are the minimal requirements for determining the presence of glaucomatous damage: detection of a cluster of at least 3 non-edge points in a location characteristic for glaucoma, all of these are depressed on the pattern deviation plot at a p <5% level, with one of them depressed at a p<1% level on 2 successive fields; a corrected pattern SD which happens in less than 5% of normal VF on 2 successive fields[10].

The steps of OCT scanning

Prior to OCT examination, mydriatic eye drops were administered to dilate the pupils as much as possible in order to ensure the best possible OCT signal and analysis in the patients' eyes. The chin rest was placed over the patient's chin. The patient was instructed to focus on a certain place inside the device. A camera that shows the fundus and scan beam is housed inside the device to complete this step. Optic disc map for peripapillary RNFL thickness; a 6.0 x 6.0 mm area centered on the optic disc was covered using a 3D raster scan protocol with 512 A-scans and 256 B-scans (6.0 x 6.0 mm - 512 x 256).

To center the scanning area, the patient was instructed to fixate on an internal fixation light (SMART Track). Prior to obtaining an OCT image, the OCT signal location and signal quality were automatically improved by machine learning. The software used motion control techniques to eliminate saccades and slight fixation loss once the volumetric OCT dataset was finished. After discarding low-quality scans, the process was repeated until high-quality scans were obtained. A mean of three measures was obtained for each peripheral RNFL, and the results were expressed as an average over 4 quadrants, 12 clock hours, and the mean thickness of the entire circumpapillary scan.

Contrast Sensitivity Assessment

Patients are assessed at one meter using a wall-mounted contrast sensitivity chart for the Pelli Robson Test. Large Sloan letters which occupy about one cycle per degree of vision are displayed on the chart. The tested range for contrast is 100% to 0.56% (log CS 0.00–2.25)[11].

The Mesotest II (Oculus Optikgeräte GmbH, Wetzlar, Germany) was used to conduct the contract and glare tests. It is made up of Landolt rings with varying contrast levels that are displayed in front of a background with low brightness. Four contrast levels—1:23, 1:5, 1:2.7, and 1:2—represent the ratio of the optotypes' light intensity to that of the background. Eight tests were administered; four had glare and four did not. The easiest to identify is Test 1, which has a contrast level of 1:23. The contrast or glare test was divided into levels for statistical analysis, with a score ranging from 20% at the 1:23 level to 100% at the 1:2 level.

Statistical analysis

For the statistical analysis version 26 (IBM, Armonk, New York, USA's SPSS (Statistical Package for the Social Sciences) was utilized. The data distribution's normality was examined using the Shapiro-Wilk test. A 95% CI P (probability) value of less than 0.05 was used for all tests, and it proved to be statistically significant. The terms mean and SD were employed to represent quantitative values, while frequency and percentage were used to express categorical data. For the purpose of comparing parametric and non-parametric continuous data between groups (between participants), the independent sample T and Mann Whitney tests were employed, respectively. The cross-tabs function was utilized to compare nominal data between groups using the Fisher exact and Chi square tests. Based on the data type, the Pearson's or Spearman's correlation coefficient was utilized to evaluate bivariate correlations.

RESULTS

This study held on 195 eyes of 105 subjects who were classified into patients group that included 95 eyes of 55 patients with POAG and control group include 100 eyes of 50

normal subjects. POAG cases were further subdivided based on severity into 39 eyes with mild glaucoma, 25 eyes with moderate glaucoma and 31 eyes with severe glaucoma according to Hodapp, Parrish and Anderson (HPA) criteria[10].

Table **(1)** demonstrates that the mean age of patients with POAG was (57.89±8.49) years, while in the control group it was (55.59±10.37) years. The majority of subjects in the study group (58.9%) were males and the control group (51.0%) were females. There were no statically significant differences among both groups as regards age and gender (P>0.05). Comparison between the clinical characteristics of the studied groups (BCVA, IOP, C/D ratio and mean deviation) shows that There was a highly statistically significant impairment in BCVA among patients group compared to the control group. Likewise, IOP was significantly increased in patients group in comparison with the controls (P<0.05).

Table (1): Demographic data and Clinical characteristic among patients and control groups.

Demographic data	Patients group (n=95)	Control group (n=100)	Test of significance	P value
Age (years)			t=1.69	0.092
Mean ± SD	57.89±8.49	55.59±10.37		
Min-Max	40-82	40-68		
Gender			χ^2 =1.94	0.164
Male	56 (58.9%)	49 (49.0%)		
Female	39 (41.1%)	51 (51.0%)		
Clinical characteristic				
BCVA	0.3 (0.0-1.0)	0.0 (0.0-0.17)	Z=9.95	≤0.001*
Median (Min-Max)				
IOP	17.29±1.38	16.50±0.0	t =5.77	≤0.001*
Mean ± SD				
Cup/disc ratio	0.736±0.14	0.57±0.06	t=11.24	≤0.001*
Mean ± SD				
Mean deviation	-7.64 (-31.06-27.48)	-1.18 (-1.18-0.67)	Z=10.21	≤0.001*
Median (Min-Max)				

t: student t test, χ^2: Chi square test & Z: Mann Whitney test, *significant p≤0.05

Table **(2) reveals** comparison between contrast sensitivity assessment using Oculus Mesotest IIb and Pelli robson among patients and control groups. The median of oculus was (4.0) in patients group and (8.0) in control group. Also, the median of pelli robson was (1.4 and 2.30) in patients and control group, respectively. There were highly statistically significant decreases in Oculus and Pelli Robson in patients group in comparison with the control group (P<0.001).

Table (2): Contrast sensitivity assessment using Oculus Mesotest IIb and Pelli robson among both groups

Contrast sensitivity assessment	Patients group (n=95)	Control group (n=100)	Test of significance	P value
Oculus Mesotest Median (Min-Max)	4.0 (0.0-6.0)	8.0 (7.0-8.0)	Z=12.61	≤0.001*
Pelli Robson Median (Min-Max)	1.4 (0.05-2.0)	2.30 (2.15-2.30)	Z=12.37	≤0.001*

t: student t test, χ^2: Chi square test & Z: Mann Whitney test, *significant p≤0.05

Table **(3)** shows that there was highly statistically significant decrease in RNFL total thickness, inferior, superior thickness, temporal thickness in patients group in comparison with the controls. Likewise, Patients group was associated with a significant reduction in nasal thickness in patients group in comparison with the controls (P<0.05).

Table (3): Retinal nerve fiber layer thickness among patients and control groups.

RNFL	Patients group (n=95)	Control group (n=100)	Test of significance	P value
RNFL total thickness	75.03±26.03	105.80±3.28	t=11.72	≤0.001*
Inferior	94.78 ± 53.50	136.85±7.62	t=7.78	≤0.001*
Superior thickness	86.08±33.85	129.35±13.76	t=11.83	≤0.001*
Nasal thickness	68.11±25.69	80.10±14.45	t=4.06	≤0.001*
Temporal thickness	55.37±18.21	76.65±9.71	t=10.30	≤0.001*

t: student t test, χ^2: Chi square test & Z: Mann Whitney test, *significant p≤0.05

The study comprised 95 eyes of cases with POAG subdivided into three subgroups based on disease severity into mild group included 39 eyes (41.1%), moderate group included 25 eyes (26.3%) and sever group included 31 eyes (32.6%) as shown in figure **(1).**

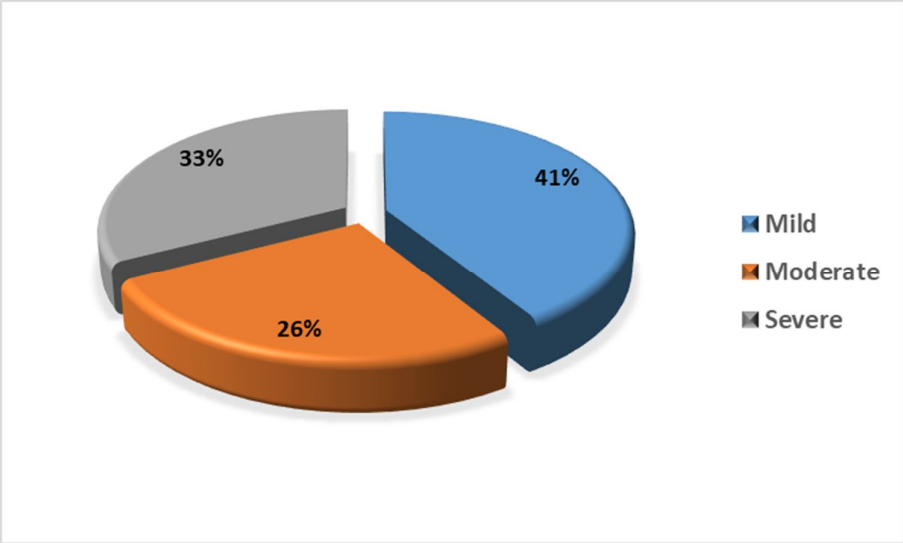

Figure (1): Severity of glaucoma among patients group

Table **(4)** reveals that there was a significant correlation between glaucoma severity and age (P<0.05), while no significant correlation was recorded regarding gender (P>0.05). The median of BCVA in mild glaucoma was 0.17(0.0-1.0), 0.30(0.0-1.0) in moderate glaucoma and 0.77(0.0-1.0) in sever glaucoma. The mean of IOP was (16.78±0.98,16.99±1.16 and18.20±1.57) in mild, moderate and sever groups, correspondingly. The mean CDR in mild glaucoma was (0.67±0.12) versus (0.73±0.14) in moderate glaucoma and (0.83±0.10) in sever glaucoma. The median of mean deviation was (-3.23) in mild glaucoma versus (-8.36) in moderate glaucoma and (-16.81) in sever glaucoma.

There were highly statistically significant correlations between glaucoma severity (either mild, moderate or severe) and both BCVA and IOP (P<0.001). Also, there were highly statistically significant correlations between glaucoma severity (either mild, moderate or severe) and (CDR and Mean deviation) (P<0.001).

Table (4): Correlation between glaucoma severity and demographic data and clinical data.

Demographic data	Mild glaucoma (n=39)	Moderate glaucoma (n=25)	Severe glaucoma (n=31)	Test of significance	P value
Age (years) Mean ± SD	55.15±7.18 a	58.08±6.93	61.19±10.04 a	F=4.73	0.011*
Gender				χ^2 =1.61	0.465
Male	20 (51.3%)	16 (64.0%)	20 (64.5%)		
Female	19 (48.7%)	9 (36.0%)	11 (35.5%)		
BCVA Median (Min-Max)	0.17 (0.0-1.0) a	0.30 (0.0-1.0) b	0.77 (0.0-1.0) ab	KW=22.78	≤0.001*
IOP Mean ± SD	16.78±0.98 a	16.99±1.16 b	18.20±1.57 ab	F=12.28	≤0.001*
Cup/disc ratio Mean ± SD	0.67±0.12 ab	0.73±0.14 ac	0.83±0.10 bc	F=16.08	≤0.001*
Mean deviation Median (Min-Max)	-3.23 (-5.81-5.04) ab	-8.36 (-11.64- -6.13) ac	-16.81 (-31.06-27.48) bc	KW=67.56	≤0.001*

F: ANOVA test, χ^2: Chi square test, a: similar letters denote significant difference between groups, KW: Kruskil wallis test, ab: similar letters denote significant difference between groups, abc: similar letters denote significant difference between groups.

Table **(5)** reveals that there were highly statistically significant correlations between glaucoma severity (either mild, moderate or severe) and contrast sensitivity assessment (Occulus and pelli robson) (P<0.001).

Table (5): Correlation between glaucoma severity and (contrast sensitivity assessment using oculus mesotest & Pelli robson).

Contrast sensitivity assessment	Mild glaucoma (n=39)	Moderate glaucoma (n=25)	Severe glaucoma (n=31)	Test of significance	P value
Oculus Mesotest Median (Min-Max)	5.0 (4.0-6.0) ab	3.0 (2.0-4.0) ac	0.0 (0.0-3.0) bc	KW=80.06	≤0.001*
Pelli Robson Median (Min-Max)	1.85 (1.25-2.0) ab	1.4 (0.5-1.7) ac	0.2 (0.05-1.01) bc	KW=77.05	≤0.001*

F: ANOVA test, χ^2: Chi square test, a: similar letters denote significant difference between groups, KW: Kruskil wallis test, ab: similar letters denote significant difference between groups, abc: similar letters denote significant difference between groups.

Table **(6)** concludes that there were highly statistically significant correlations between glaucoma severity (either mild, moderate or severe) and all RNFL parameters (Temporal thickness, Inferior thickness, Superior thickness, Nasal thickness and RNFL total thickness) (P<0.001).

Table (6): Correlation between glaucoma severity and RNFL thickness in glaucoma group.

RNFL	Mild glaucoma (n=39)	Moderate glaucoma (n=25)	Severe glaucoma (n=31)	Test of significance	P value
RNFL total thickness	94.13±18.56 ab	67.28±19.51 a	57.26±23.04 b	F=30.75	≤0.001*
Inferior	124.33±61.11 ab	82.84±30.06 a	67.23±38.43 b	F=13.53	≤0.001*
Superior thickness	112.36±24.86 ab	74.60±24.62 a	62.29±27.04 b	F=36.64	≤0.001*
Nasal thickness	84.00±22.07 ab	61.56±20.76 a	53.39±22.79 b	F=18.25	≤0.001*
Temporal thickness	66.18±13.08 ab	49.52±17.91 a	46.48±17.41 b	F=15.52	≤0.001*

F: ANOVA test, χ^2: Chi square test, a: similar letters denote significant difference between groups, KW: Kruskil wallis test, ab: similar letters denote significant difference between groups, abc: similar letters denote significant difference between groups.

Table (7) shows that there were highly statistically significant correlations between contrast sensitivity assessment using both (Oculus mesotest and Pelli robson) and all RNFL parameters (Temporal thickness, Inferior thickness, Superior thickness, Nasal thickness and RNFL total thickness) (P<0.001).

Table (7): Correlation between contrast sensitivity assessment using oculus mesotest IIb and Pelli Robson and retinal nerve fiber layer thickness.

RNFL	Occulus		Pelli Robson	
	R	P value	R	P value
RNFL total thickness	0.815	≤0.001*	0.771	≤0.001*
Inferior thickness	0.763	≤0.001*	0.742	≤0.001*
Superior thickness	0.788	≤0.001*	0.737	≤0.001*
Nasal thickness	0. .692	≤0.001*	0.613	≤0.001*
Temporal thickness	0.660	≤0.001*	0.627	≤0.001*

DISCUSSION

Glaucoma is described as a progressive optic neuropathy, featured by structural damage of optic nerve with associated VFL. POAG is the commonest type. Though perimetry is the best approach, pre-perimetric glaucoma can be reliably detected with RNFL by SD-OCT[12]. Essentially, the structure-function relationship between RNFL and the VF in glaucoma is extensively studied; however, there is limited data about the correlation between RNFL and CS[13]. Thus, the aim of the current study was to evaluate the correlation between contrast sensitivity and RNFL thickness in cases with POAG.

Regarding severity of glaucoma among patients group, the present study demonstrated that most of the studied cases were mild (41.1%), while severe and moderate degrees were recorded in (32.6%) and (26.3%) of cases respectively. Also, Abd El-Naby and his colleagues[14] conducted their study on 80 eyes of 80 patients. The eyes were classified into Normal age-matched patients included 20 and Patients with POAG who were classified based on disease severity into 22 patients experiencing early glaucoma, 20 patients with moderate glaucoma and 18 patients having severe glaucoma according to HPA criteria.

Regarding BCVA & IOP, the current study demonstrated that there was a highly statistically significant decrease in BCVA among patients group in compsriosn with the controls. In the same line, IOP was significantly increased in patients group in comparison with the controls (P<0.05). In the same line, Soliman and his colleagues[15] have reported a positive association between the groups as regards mean IOP (18.40±4.08 versus 13.20 ±1.88) (P<0.001), on the other hand they were in disagreement with our result in terms of BCVA as they have found a non-significant association between both groups with regard to BCVA (P=0.127).

Regarding cup/disc ratio, the current study demonstrated that patients group were linked to an extremely substantial rise in cup/disc ratio (0.736±0.14 versus 0.57±0.06). As regard to

VF assessment, patients group had a significantly higher decrease in mean deviation (-7.64 versus -1.18) in comparison with the controls (P<0.001).In accordance, Soliman and his colleagues[15] have displayed a positive significant association among the groups as regards cup-to-disc ratio (P<0.001) (0.63±0.10 versus 0.46±0.06).

Regarding contrast sensitivity assessment, our study demonstrated that there were highly statistically significant decreases in Oculus Mesotest and Pelli Robson in patients group in comparison with the controls (P<0.001). Regarding RNFL, our study revealed that; there was highly statistically significant decrease in RNFL total thickness, Inferior, Superior thickness, Temporal thickness in patients group compared to the control group. Likewise, Patients group was associated with a significant reduction in Nasal thickness in patients group compared to the control group (P<0.05).

In agreement, Soliman and his coworker[15] have displayed that; there was a positive significant correlation between both groups as regards the average RNFL thickness (P<0.001) (25.55 ±3.97 μm versus 56.95 ±9.68 μm). The superior average thickness was 25.35±6.31 μm, in group 1 versus 55.95±9.43 μm in group 2. The inferior average thickness was 26.35±4.58 microns in group 1 versus 58.30±10.15 μm in group 2. With regard to association between glaucoma severity and demographic data, the current study displayed that; there was a statistically significant correlation between glaucoma severity and age (P<0.05), while no significant association was reported as regard gender (P>0.05).

In terms of association between glaucoma severity and both (BCVA & IOP), our study demonstrated highly significant correlations between glaucoma severity (either mild, moderate or severe) and both BCVA and IOP (P<0.001). Regarding association between glaucoma severity and Cup/disc ratio, our study demonstrated highly significant correlations between glaucoma severity (mild, moderate or severe) and cup/disc ratio (P<0.001). Also, highly significant correlations existed between glaucoma severity (either mild, moderate or severe) and VF assessment (Mean deviation) (P<0.001). In the same line, Bhat and his colleagues[12] have demonstrated that the average mean deviation was 11.84 ± 8.88 dB. The Chi-square test comparing mean deviation in eyes with mild, moderate, and severe disease demonstrated a significant difference mean deviation between the 3 groups (*P* < 0.001).

As regards association between glaucoma severity and contrast sensitivity assessment, our study demonstrated that there were highly significant correlations between glaucoma severity (either mild, moderate or severe) and and contrast sensitivity assessment (Oculus and Pelli robson) (P<0.001). Fatehi and his colleagues[16] have reported that; CS at 6 cpd had the strongest association with mean SD of the four central VF points (p<0.001). A significant association existed between logMAR VA and CS at 6, 12, and 18 cpd (p<0.013).

Concerning association between glaucoma severity and RNFL, present study y demonstrated highly significant correlations between glaucoma severity (either mild, moderate or severe) and all RNFL parameters (Temporal thickness, Inferior thickness, Superior thickness, Nasal thickness and RNFL total thickness) (P<0.001). In the same line, Abd El-Naby and his coworker[14] carried out their study on 20 healthy and 60 glaucomatous eyes. They have reported that; the average RNFL loss was 14.9%, 25.1% and 37.2% in early, moderate and severe glaucoma, respectively. subjects with early glaucoma had significantly higher average RNFL measurements than moderate and severe glaucoma. Furthermore, cases with moderate glaucoma had significantly higher RNFL measurements than those with severe glaucoma. Furthermore, healthy eyes showed significantly higher RNFL measurements than all glaucoma degrees. A statistically significant relationship was discovered between average RNFL thickness and mean deviation. Thus, they concluded that; the average RNFL thickness has a good diagnostic value for glaucoma diagnosis and for glaucoma stage differentiation based on severity. The current study came in agreement with the study of Golzan and his colleagues[17] who evalauted RNFL thickness in glaucoma cases and healthy controls. They have found that glaucoma cases had significantly lower RNFL thickness than controls (87±26vs. 111±15 μm, P<0.0001).

In the context of the correlation between contrast sensitivity and RNFL, our study revealed that; there were highly statistically significant correlations between Pelli robson and all RNFL parameters (Temporal thickness, Inferior thickness, Superior thickness, Nasal thickness and RNFL total thickness) (P<0.001). Likewise, Amanullah and his

colleagues[12] have demonstrated in their study on glaucomatous eyes that; CS in the left upper visual area for the two eyes associated mainly with the thickness of the inferior quadrant of the RNFL in the two eyes. When stratifying by clock hours, such associations seems to be driven by the 7 o'clock sector for the left eye and by the 6 o'clock sector for the right eye.

Nakatani et al., 2011[18] who assessed the diagnostic ability of peripapillary RNFL measurements for early glaucoma, the authors found significant differences between early glaucoma and normal patients in entire parameters with exception of fovea in macular scans and in the superior and inferior quadrants at 12, 3, 6, 7, and 11 o'clock positions.

Miki et al. 2014[19] used RNFL thickness measurements by OCT to predict VF loss in patients with glaucoma. The study found that the rate of RNFL loss was more than double as fast in eyes which developed VFL in comparison with eyes that didn't develop VF defect.

This came in the same line with Sehi et al., 2013[20] who compared (in a prospective manner) the determination of extensive RNFL loss by utilizing time-domain OCT with VF progression using automated perimetry in glaucoma suspect and in cases with glaucoma who were devoid of perimetric changes. They revealed that structural progression is associated with functional progression in glaucomatous eyes.

CONCLUSION

In the context of cases with POAG, contrast sensitivity has been demonstrated to be associated with significant correlations with both retinal nerve fiber layer thicknesses as well as with glaucoma severity. There was a moderate assoiation between deteriorating VF indeces and reduced CS.

Declarations

Conflict of Interest

None

Funding

For this review, no financial sources were utilized.

Disclosures

None

Declaration of Interest

No financial relationship or connection with any entity or group that has a financial competing in the materials or subject matter under consideration.

Consent for publication.

None

Availability of Data

Entire data generated throughout this review are comprised in the study.

Standards of Reporting

CONSORT guidelines were followed.

Authors contributions

The initial draft of the manuscript had been written by the authors after they had evaluated and discussed the data.

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