CORRELATION OF RETINAL NERVE FIBRE LAYER ANALYSIS BY OPTICAL COHERENCE TOMOGRAPHY WITH VISUAL FIELDS BY STATIC AUTOMATED PERIMETRY IN PATIENTS WITH PRIMARY OPEN ANGLE GLAUCOMA

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ABSTRACT

Aim: The aim of the present study was to evaluate the correlation of retinal nerve fibre layer analysis by optical coherence tomography with visual fields by static automated perimetry in patients with primary open angle glaucoma.

Methods: The descriptive cross-sectional study was conducted at Tertiary Care Hospital in Western Maharashtra for the period of September 2020 to August 2022. 50 patients were included in the present study. Ethics committee clearance was obtained prior to the start of study. Written and informed consent was taken from all patients before undertaking the study.

Results: Males and females were of equal proportions in our study.The mean age of the patients was 55.9 years and duration of POAG was 2.5 years.In our study, 38% had diabetes and 40% had hypertension.38% of the patients had a positive family history of Glaucoma.Majority of the participants reported a distant vision of 6/9 in the right eye as well as left eye(36%). N6 was the most commonly reported near vision of RE (84%) as well as left eye (88%).There was a significant positive correlation between average RNFL thickness, rim area, temporal field RNFL, minimum GCL+ IPL thickness and the right and left eye MD. There was a significant negative correlation between vertical C:D ratio, av C:D, cup volume and right and left eye MD.

Conclusion: When comparing RNFL and GCL complex analysis by OCT, GCL analysis proved to be superior at recognizing early glaucomatous alterations. The evaluation of peripapillary RNFL thickness with macular GCL analysis can be utilized in conjunction with visual field assessment to diagnose early POAG.

Keywords:open-angle glaucoma, perimetry, retinal nerve fiber layer thickness, optical coherence tomograph

INTRODUCTION

Glaucoma is a group of diseases, characterized by optic neuropathy consistent with remodeling of connective tissue of the optic nerve head and loss of neural tissue associated with the development of visual field defects. Approximately 11.2 million people in India suffer from glaucoma, of which 6.48 million have primary open-angle glaucoma (POAG).[1] The structural changes due to retinal ganglion cell (RGC) loss lead to functional visual field loss. Perimetry is used as a base line at diagnosis as well as for monitoring of the disease.

The classification of glaucoma into various stages helps in the assessment and documentation of visual field loss, allowing the detection of progression. It is sensitive and specific, but subjective and shows intertest variability.[2] Visual field defects are found after 25%–30% RGC loss[3] which may lead to patients with early glaucomatous damage remaining undetected.Optical coherence tomography (OCT) is more sensitive to changes in visual function than perimetry. Since it specifies the RNFL thickness in various quadrants, the area most susceptible to damage can be determined. It is especially useful in patients whose perimetric results are not reliable.[4]

Optical coherence tomography (OCT) is an innovative diagnostic tool in tomographic imaging of tissues. In the field of ophthalmology, its ease of access to different areas in the eye allows its use as an excellent diagnostic technology.[5]Spectral-domain optical coherence tomography (SDOCT) is superior to time-domain OCT in performing scanning with higher axial resolution, faster speed and better reproducibility.[6]Chronic progressive optic neuropathy is the descriptive pathogenesis of primary open-angle glaucoma (POAG), which is associated with optic disc cupping and visual field (VF) changes with no obvious systemic or ocular cause.[7]

As glaucoma is listed as the second leading cause of blindness among population, its early diagnosis is crucial. Standard VF examinations are used in the diagnosis and follow-up of glaucoma, but one of its drawbacks is that the abnormalities do not appear until 20–40% of ganglion cells are lost. Earlier defects in the retinal nerve fiber layer (RNFL) measured by OCT provide an excellent objective and quantitative method in the diagnosis and management of glaucoma.[7]The use of low coherence interferometry in recording the echo time delay and intensity of backscattered light from various layers of the retina allows OCT to achieve an accurate measurement of the peripapillary RNFL thickness.[8]

There is no consensus at this time on which tests-structural or functional-are the most reliable in detecting early glaucomatous damage. Varied imaging tools and various perimetries have been used in the past to investigate the link between structural and functional testing.[9]

The aim of the present study was to evaluate the correlation of retinal nerve fibre layer analysis by optical coherence tomography with visual fields by static automated perimetry in patients with primary open angle glaucoma.

Materials and Methods

The descriptive cross-sectional study was conducted at Tertiary Care Hospital in Western Maharashtra for the period of September 2020 to August 2022. 50 patients were included in the present study. Ethics committee clearance was obtained prior to the start of study. Written and informed consent was taken from all patients before undertaking the study.

Inclusion criteria:

All Patients of age more than 45 years but less than 70 years diagnosed with primary open angle glaucoma.

Exclusion criteria:

1. Other causes of raised Intraocular pressure
2. Primary and secondary angle closure glaucoma
3. Secondary causes of open angle glaucoma
4. Any ocular inflammation
5. Other causes of optic neuropathy
6. Congenital glaucoma
7. Post traumatic glaucoma
8. Any history of ocular surgery
9. Inability to evaluate optic disc due to media haze
10. Inability to evaluate Intraocular pressure due to corneal surface abnormalities
11. Unable to assess visual fields due to poor vision
12. Unable to perform OCT due to media haze

Methodology

A detailed history was taken in all patients. History of predisposing factors like Age, Myopia, Family history, Trauma, Surgery, Ocular Inflammation, Associated Systemic illness like Diabetes, Hypertension, Thyroid disorders and Cigarette smoking was taken.

All patients needed to undergo a thorough clinical examination including:

1. Snellen's visual acuity testing

2. Slit Lamp Examination of anterior segment

3. Tonometry with Goldmann Applanation Tonometer (GAT)

4. Pachymetry

5. Gonioscopy using Gonioprism 4 mirror lens

6. Fundoscopy by Direct Ophthalmoscopy, Indirect Ophthalmoscopy, Slit Lamp biomicroscopy using 20D and 90D lens

7. Functional Testing by visual field charting on Humphrey field analyzer Swedish Interactive Threshold Algorithm (SITA) 24-2 standard strategy automated perimetry

8. Structural Testing of optic disc with retinal nerve fibre analysis by Spectral Domain Optical Coherence Tomography.

Statistical Analysis

Data was entered in MS excel. Analysis was conducted in SPSS v26.0. Frequencies and proportions were used to express categorical variables. The Kolmogorov Smirnov test was used to assess the normality of continuous variables, which were found to be not normally distributed. The Mann-Whitney test was used to assess the association between sex, comorbidities and continuous variables. To investigate the relationship between continuous variables, Spearman correlation was applied. Appropriate graphs were made for the results. A statistically significant p value of 0.05 is considered.

Results

Table 1: Patient characteristics

Variables	**N%**
Gender	
Male	25 (50)
Female	25 (50)
Mean± SD	55.9±9.3

History of diabetes mellitus	
Yes	19 (38)
No	31 (62)
Duration of POAG Mean± SD	2.5±2
History of hypertension	
Yes	20 (40)
No	30 (60)
History of glaucoma	
Yes	19 (38)
No	31 (62)

Males and females were of equal proportions in our study.The mean age of the patients was 55.9 years and duration of POAG was 2.5 years.In our study, 38% had diabetes and 40% had hypertension.38% of the patients had a positive family history of Glaucoma.

Table 2: Distribution of patients based on distant visual acuity in the Right eye (RE) and Left eye (LE)

Distant Vision	**Right eye N%**	**Left eye N%**
6/6	9 (18)	5 (10)
6/9	18 (36)	18 (36)
6/12	8 (16)	10 (20)
6/18	3 (6)	4 (8)
6/24	7 (14)	1 (2)
6/36	1 (2)	5 (10)
6/60	3 (6)	6 (12)
5/60	1 (2)	1 (2)
Near vision		
N6	42 (84)	44 (88)
N8	1 (2)	1 (2)
N9	7 (14)	5 (10)

Slit Lamp Examination		
WNL	17 (34)	21 (42)
Grade 1 NS	16 (32)	13 (26)
Pseudophakia	17 (34)	16 (32)

Majority of the participants reported a distant vision of 6/9 in the right eye as well as left eye(36%).N6 was the most commonly reported near vision of RE (84%) as well as left eye (88%).Majority of the patients had pseudophakia in their right eye, (34%), followed by Grade 1 NS (24%). Similarly, Majority of the patients had pseudophakia in their left eye, (32%), followed by Grade 1 NS (26%). The mean Intra ocular pressure in the right and left eye are 20 and 21.3 respectively. The mean Pachymetry in both eyes are 540.3. In the right eye, the mean of the average RNFL thickness by OCT was 78.8. The average RNFL symmetry is 62.9, the rim area is 1.1, the disc area is 2, the average C:D ratio is 0.63, the vertical C:D ratio is 0.63, and the cup volume is 0.41. In the left eye, the mean of the average RNFL thickness by OCT was 73.1. The average RNFL symmetry is 62.9, the rim area is 0.87, the disc area is 2, the average C:D ratio and the vertical C:D ratio are both 0.73, and the cup volume is 0.53.

Table 3: Correlation between Right Eye, Left Eye MD, RNFL thickness and other OCT parameters

Variable	**Mean**	**SD**	**Median**	**IQR**
IOP				
RE	20	4.1	18	16,22.5
LE	21.3	5.1	22	18,24
Pachymetry				
RE	540.3	2.2	540	540,542
LE	540.3	2.2	540	540,542
RE OCT				
Av RNFL thickness	78.8	13	79	68.8,88
RNFL symmetry	62.9	26.7	63	59,87

Rim area	1.1	0.3	1.1	0.8,1.3
Disc area	2	0.4	2	1.7,2.2
Av C/D ratio	0.63	0.15	0.65	0.51,0.72
Vertical C/D ratio	0.63	0.17	0.66	0.49,0.72
Cup volume	0.41	0.27	0.39	0.11,0.61
LE OCT				
Av RNFL thickness	73.1	15.3	76.5	59,86
RNFL symmetry	62.9	26.7	63	59,87
Rim area	0.87	0.31	0.87	0.54,1.16
Disc area	2	0.4	1.9	1.7,2.1
Av C:D ratio	0.73	0.13	0.73	0.6,0.85
Vertical C:D ratio	0.73	0.12	0.77	0.66,0.83
Cup volume	0.53	0.31	0.56	0.24,0.77
RE Fields RNFL				
Superior	90.7	20.5	96	77,102
Inferior	93.7	23.6	99	71,109.3
Nasal	66.8	14.9	68	53,81
Temporal	63.7	18.9	58	48,74
LE Fields RNFL				
Superior	86.7	25.4	89	68,103
Inferior	78.3	26.5	66	61,94
Nasal	60.2	13.4	58	46,69.5
Temporal	53.8	11	57	45.5,58.3
RE GCL				
Av GCL+IPL thickness	76.4	9.8	76	68,86
Min GCL+ IPL thickness	68.8	12	69	56,77
LE GCL				

Av GCL+IPL thickness	69	10.3	71.5	59.5,76.5
Min GCL+ IPL thickness	57.6	14.1	56	48,70.3
Perimetry				
RE				
MD	-6.8	7	-4.2	-10.9,-3.1
PSD	5.4	3.8	4.4	1.8,9.5
LE				
MD	-8.2	6.7	-6.6	-11.7,-3.3
PSD	6.3	3.7	7.2	2.1,8.1

There was a significant positive correlation between average RNFL thickness, rim area, temporal field RNFL, minimum GCL+ IPL thickness and the right and left eye MD. There was a significant negative correlation between vertical C:D ratio, av C:D , cup volume and right and left eye MD.

DISCUSSION

The study was done on a sample of 50 participants with open angle glaucoma to analyze the correlation of RNFL by OCT with visual fields by static automated perimetry in patients. Males and females were of equal proportion in the study. In the study by Firat PG, et al.,[10] on POAG patients, also males (51.6%) and females were almost equally distributed. In the current study, the mean age of the patients with POAG was 55.9 ± 9.3 years. In a similar study by Bhat KS, et al.[11], also compared the RNFL with perimetric staging in 27 POAG patients with a mean age of ± 10.1 years. But Sato S, et al.[12], had POAG patients with a higher mean age of 61.2 ± 14.5 years.

The mean C:D ratio of the right was 0.63 and left eye 0.73 in the current study. In the study by Kumar L, et al.[13], also the average C:D ratio was slightly higher in the left eye (0.66 ± 0.1) than the right eye (0.65 ± 0.1). The right eye average C:D ratio was almost similar in the current study and the study by Kumar L, et al.[13], Brandao LM, et al.[14], reported a higher C:D ratio of 0.8 (0.5–

0.9). CCT plays an important role in assessing target IOP for diagnosed POAG cases. The mean Pachymetry reading of corneal thickness in the right and left eye were the same at 540.3 ± 2.2. In the study by Bhat KS, et al.[11], also the mean CCT was slightly lower (529±17.3) than the current report. In the study by Kumar L, et al.[13], CCT was measured using ultrasound pachymeter and it showed that the mean of right and left eye was 515 ± 28.5 and 517.5 ± 30.8 respectively. In the current study the mean global RNFL thickness in the right and left eye were 78.8 μm and 73.1 μm respectively on OCT. In the study by Gyatsho J, et al.[15], Bhat KS, et al.[11], and Brandao LM, et al.[14], the mean RNFL thickness was lower at 60.4± 16.6, 62.4 ± 17.7 μm and 69.4±11 μm respectively. In the current study a positive correlation between MD and average RNFL thickness, rim area, temporal field RNFL, minimum GCL+ IPL thickness was observed in both the eyes. The study by Bhat KS, et al.[11] also showed that there was a significant positive correlation between MD with RNFL loss and visual field index (VFI). This correlation was consistent in all sectors of RNFL in severe POAG cases.

In the current study, a positive correlation was seen between GCL and OCT RNFL thickness in both the eyes. In accordance with the current findings, the study by Firat PG, et al.,[11] also all three RNFL thicknesses (average, superior, and inferior) parameters correlated significantly with all GCC thickness parameters in the POAG group. In the current study, there was a significant negative association between age and the global average OCT RNFL thickness of the right eye. However, this finding was not consistent in the left eye. In the study by Sony P, et al.[16] also a similar negative correlation of RNFL thickness was observed with age in the global, superior and inferior average values but not in the nasal and temporal regions. Varma R, et al.[17] studied the relation between age and RNFL thickness in normal eyes and reported a similar finding that they were negatively correlated in all quadrants separately and also on global average.

In the current study a significant negative correlation between duration of POAG and the right eye was observed however this finding was not consistent in the left eye. In the study by Badlani V, et al.,[18]the duration of POAG was not studied, but when corelated with severity of POAG, it was seen that RNFL thickness significantly reduced in advanced glaucoma. Moghimi S, et al.,[19] conducted a longitudinal study among glaucoma patients and concluded that RNFL thickness declined with time. In the current study both the eyes showed a significant positive correlation between MD and RNFL thickness. In accordance with this finding, Badlani V, et al.,[18] also

reported there is a linear relationship between hemifield Retinal Nerve Fibre layer thickness and Mean Deviation in both early and advanced glaucoma.

In this study, there was a significant correlation found between VF loss and RNFL thickness. Moreover, nerve thinning was more significant in cases with severe glaucoma when compared with patients with mild and moderate glaucoma. This is in accordance with the study by Sehi et al.[20]that compared prospectively the detection of progressive RNFL loss using time-domain OCT with VFprogression using standard automated perimetry in glaucoma suspect and in patients with glaucoma with and without perimetric changes. They found that structural progression is accompanied with functional progression in glaucoma suspect and glaucomatous eyes. Average and superior RNFL thickness may give the clue for further standard automated perimetry loss.This is in agreement with the study of Alasil et al.[21] who studied 108 patients with glaucoma in addition to 78 healthy controls. The participants were subjected to perimetry analysis and RNFL OCT scans aiming to detect the RNFL thickness threshold at which VF loss begins to be clinically detectable. The study revealed a statistically significant correlation between RNFL thickness and corresponding VF loss.

CONCLUSION

The mean deviation was strongly correlated to the RNFL thickness and the ganglion cell layer complex. PSD was shown to be moderately correlated to RNFL thickness. OCT can detect changes at the RNFL level in early primary open angle glaucoma with normal visual fields. OCT measurements of RNFL thickness have been demonstrated to be reliable and reproducible. It has been shown to improve diagnostic accuracy in RNFL evaluation. When comparing RNFL and GCL complex analysis by OCT, GCL analysis proved to be superior at recognizing early glaucomatous alterations. The evaluation of peripapillary RNFL thickness with macular GCL analysis can be utilized in conjunction with visual field assessment to diagnose early POAG.

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