

Structural and Functional Correlation in Glaucoma Patients**Dr Afra Binti Iqbal¹, Dr Sajad Khanday², Dr Seema Malik³**¹Department of Ophthalmology, Government Medical College Srinagar²Associate Professor, Department of Ophthalmology, Government Medical College Srinagar³Department of Ophthalmology District Hospital Reasi

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Conflict of interest: Nil

Abstract**Objectives:** To compare retinal nerve fiber layer thickness changes on optical coherence tomography with automated perimetry indices in patients with glaucoma.**Methods:** Comprehensive clinical assessment, visual field testing and OCT every 6 months were done in 64 eyes of 40 glaucoma patients.**Results:** Moderate Positive correlation was seen between RNFL and perimetric mean deviation at all visits with r values of 0.56, 0.55, 0.52 and 0.53 at 0, 6, 12 and 18 months respectively. Correlation is found to be statistically significant at p value <0.05. Moderate negative correlation was seen between Average RNFL thickness and perimetric Pattern standard deviation with r-values of -0.43, -0.45, -0.46, -0.47 at 0, 6, 12 and 18 months. Correlation is statistically significant with p value <0.01 level (2 tailed).**Conclusion:** significant correlation exists between OCT RNFL and mean deviation on Perimetry in the progression of glaucoma. Structural changes documented by the RNFL scanning on OCT tend to occur earlier than the functional changes documented by Perimetry. Therefore, RNFL scanning is more sensitive for detecting early glaucomatous changes whereas Perimetry is more sensitive to subtle changes in moderate to advanced glaucoma.**Keywords:** Glaucoma, Perimetry, mean deviation, pattern standard deviation, optical coherence tomography, retinal nerve fibre later thickness, best corrected visual acuity, central corneal thickness, intra ocular pressure, cup disc ratio.

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Introduction

Glaucoma is a large group of disorders characterized by widely diverse clinical and histopathological manifestations [1]. It encompasses group of eye conditions, which causes progressive optic nerve damage, retinal nerve fibre loss, retinal ganglion cell death and corresponding visual field defects [2]. The common denominator of the glaucomas is a characteristic optic neuropathy, which derives from various risk factors that include but are not limited to increased intraocular pressure. Glaucoma can remain asymptomatic until it is severe, resulting in a high probability that number of individuals affected is much higher than the number known to have it [3,4]. Several Population-level surveys propose that only 10% to 50% of people with glaucoma are aware they have it [5-7]. Glaucomatous visual losses can be prevented by early diagnosis and treatment; efforts to improve early diagnosis of glaucoma are therefore an essential component of reducing visual loss due to glaucoma [8]. The key to glaucoma diagnosis is identification of the

morphological changes to the optic nerve head and retinal nerve fiber layer (RNFL) that result from retinal ganglion cell loss. Several recently developed laser scanning imaging techniques like optical coherence tomography provide more objective and quantitative information about the amount of optic nerve fiber (retinal nerve fibre layer and ganglion cell) loss.

Assessment of visual function is also important in glaucoma diagnosis, with the prevailing test being Standard Automated Perimetry (SAP), presence of characteristic visual field defects can confirm the diagnosis, but studies have shown that 30% to 50% of retinal ganglion cells may be lost before defects are detectable by standard visual field testing [9-17].

This study has focused on correlating the changes of retinal nerve fiber layer on Spectral domain OCT with the visual field mean deviation on standard automated Perimetry (Humphreys 24-2) in the patients of glaucoma.

Methods and Materials

This was an observational, prospective, hospital based study that was conducted in postgraduate department of ophthalmology GMC Srinagar over a period of 18 months. The study was started after obtaining the ethical clearance from institutional ethical committee.

Diagnosed cases of glaucoma belonging to the age group 12 years and above were included in the study. The definition of Glaucoma was based on abnormal Standard Automated Perimetry (SAP) test result on 24-2 program of visual field (Humphrey Field Analyser) or if progressive glaucomatous optic disc changes (e.g. rim thinning, enlargement of optic disc cup, and defects in retinal nerve fiber layer) was noted.

After explaining the purpose and procedure of the study an informed consent of the patient was taken. Demographic information, medical history, drug history, personal history will be taken. A complete ophthalmologic examination including measurement of best corrected visual acuity (BCVA), IOP determination using applanation tonometry and fundus examination was performed. Stereoscopic examination of the optic disc and peripapillary area was performed at the slit lamp using 78-D lens. The following disc features evoked suspicion of glaucomatous damage: Vertical cup disc ratio (CDR >0.5) in either eye. Asymmetry of CDR > 0.2 between the two eyes. Thin or notched neuroretinal rim, optic disc pallor and disc hemorrhage. Nerve fiber layer defect with the corresponding characteristic changes in the visual field.

After the basic ophthalmologic examination, patients underwent Humphrey full-threshold 24-2 achromatic Perimetry or Swedish Interactive Thresholding Algorithm standard 24-2 Perimetry. Humphrey Field Analyser (HFA) (Carl Zeiss Meditec, Jena, Germany Model 750i) is the commonly used perimeter for visual field assessment in glaucoma clinics. Perimetry assesses the ability of retina to detect a stimulus at specific points within the visual field.

This is called retinal sensitivity and is recorded in 'decibels' [18]. The threshold value for each of the tested location within the field represent the extent to which light can be dimmed and still detected by the patient and are referenced to age-matched normal population values. These multiple location-based data are then aggregated and presented as global indices which provide a useful summary of the field.

The Mean Deviation (MD) is derived from the Total Deviation and represents the overall mean departure of the test subject's visual field sensitivity from the age-corrected norm. Negative

values indicate field loss whereas positive values indicate that the field is above average. The Pattern Standard Deviation (PSD) summarises localised loss while correcting for an overall depression in light sensitivity [19].

The visual field was tested up to 24 degrees temporally and 30 degrees nasally from fixation With SITA strategies unreliable test was defined as any test having false positive and false negative > 15 % and fixation losses over 30%.

Then central corneal thickness measurement, RNFL imaging and measurement by Cirrus HD OCT model 5000 was done. It has a 840nm wavelength five parallel scan (4096 scans / line) to view high resolution corneal images. The cornea is viewed using the anterior segment mode. All patients were instructed to fixate on the target and pachymetry scan was performed.

Using spectral domain Cirrus HD OCT (Carl Zeiss Meditec Inc., Model 5000), RNFL (retinal nerve fiber layer), and ONH (optic nerve head): optic disc cube 200x200 program was performed to find out the average RNFL thickness and RNFL symmetry after proper dilatation of eyes with 1% tropicamide and 2.5% phenylepinephrine.

The follow up of patients was done 6 monthly upto 18 months. At each follow up BCVA, Adjusted IOP, fundus examination, Perimetry and OCT RNFL was done.

Inclusion criteria:

1. Glaucoma patients above 30 years of age.
2. Best corrected visual acuity > 6/60.

Exclusion criteria:

1. Angle closure glaucoma
2. Media opacities
3. Retinal and optic nerve lesions other than attributed to glaucoma.

Results:

In our study, patient's age ranged between 30-80 years with the mean age of 59 ± 8.96 years. Most common age group affected was 50-59 years constituting about 37.5%, 32.5 % patients belonged to 60-69 years, 17.5% to 40-49 years of age group. 1 patient (2.5 %) was in the 30-39 years age group and 4 patients (10%) were more or equal to 70 years.

In our study, there was decrease in best-corrected visual acuity in 8 eyes whereas it remained stable in 56 eyes over a period of 18 months. The mean adjusted IOP was 16.83 ± 3.79 , 16.50 ± 5.01 , 15.82 ± 3.93 , 15.43 ± 3.98 mmHg at 0 month, 6 months, 12 month and 18 month respectively.

In our study, 10 eyes (15%) showed increase in cup disc ratio from baseline whereas 54(85%) eyes

showed no change In our study mean RNFL thickness was $77.62 \pm 14.88 \mu\text{m}$, $75.83 \pm 14.26 \mu\text{m}$, $74.36 \pm 14.44 \mu\text{m}$, $72.40 \pm 14.46 \mu\text{m}$ at 0,6,12 and 18 months respectively. 25 eyes (39.06%) showed decrease in RNFL thickness $> 5 \mu\text{m}$ (structural changes) on OCT RNFL whereas 1 eye (1.56%) showed increase in RNFL thickness and 38 eyes (59.38%) remained stable. In our study, 16 eyes

(25%) showed decrease of $> 1 \text{ dB}$ (functional change) in mean deviation. In our study, total of 29 eyes showed either decrease in RNFL or mean deviation on Perimetry. 11 eyes showed simultaneous decrease in RNFL thickness and mean deviation on OCT and Perimetry respectively. MD Perimetry* RNFL Cross tabulation

Table 1: MD * RNFL Cross tabulation

		RNFL			Total
		No Change	Decrease	Increase	
MD	Decrease	5	11	0	16
	No change	33	14	1	48
Total		38	25	1	64

Correlation between RNFL thickness, Perimetric Mean deviation and Pattern standard deviation

Table 2: correlation between RNFL, Perimetry mean deviation and pattern standard deviation at 0 month

	RNFL	PSD	MD
RNFL	1		
PSD	-.437**	1	
MD	0.563**	-0.319*	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Table 3: Correlation between RNFL, Perimetry MD, PSD at 6 month

	RNFL	PSD	MD
RNFL	1		
PSD	-.451**	1	
MD	0.552**	0.295*	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 4: Correlation of RNFL with perimetric MD and PSD at 12 months

	RNFL	PSD	MD
RNFL	1		
PSD	-.469**	1	
MD	0.528**	0.301*	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 5: Correlation between RNFL and perimetric MD, PSD at 18 months

	RNFL	PSD	MD
RNFL	1		
PSD	-.471**	1	
MD	0.531**	0.314*	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Discussion:

This study was conducted in Postgraduate department of ophthalmology in Government medical College for a period of 18 months. The study included 64 eyes of 40 subjects who attended outpatient department of ophthalmology and were diagnosed with various types of glaucoma. Commonest age group affected in our study was 50-59 years in 37.5% patients followed by 60-69 years in 32.5% patients, 40-49 years in 17.5%. Mean age of patients in our study was 59.2 ± 8.95 years with a range of 30-80 years. Similar results were obtained by Tenkumo K et al. in 2013. In their study the mean age of patients was 63 ± 10.4 years

[20]. Lopez-Peña MJ et al. in 2011 determined Relationship between Standard Automated Perimetry and Retinal Nerve Fiber Layer Parameters Obtained with Optical Coherence Tomography with a mean age of 60.96 ± 7.29 years in the glaucoma patients. [21]

In present study, the gender distribution was comparable with slight male predominance constituting 55% of study population. The results are consistent with Leung CK, et al who had 51 male patients as compared to 30 female patients in their study [19]. Nassar MK, et al also found the male predominance in their study with males constituting about 74% of study population [22].

However there are many studies which have female predominance of the study patients.

Mean IOP in the study population at baseline was 16.83 ± 3.79 mmHg. Asrani S et al observed that the mean IOP was 17.6 ± 3.2 mmHg in a study involving 64 patients with POAG [23]. Similar results of base line IOP in glaucoma patients was found by Naito T et al [24]. The mean IOP in this study was 16.6 ± 3.7 mmHg.

The average RNFL thickness at baseline was 77.62 ± 14.88 and at last visit was 72.40 ± 14.46 . These results are contrary to that seen by Leung CK, et al, who observed that average baseline and last visit RNFL thickness was 72.70 ± 15.97 and 72.54 ± 15.27 respectively [19]. However our observation is in agreement with the study done by Wollstein G, et al. In their study, baseline RNFL and last visit RNFL thickness was 94.0 ± 21.9 μ m and 82.3 ± 25.3 μ m respectively [25]. In another study by Leung CK et al they found that baseline Average RNFL and last visit average RNFL was 77.66 ± 19.58 and 73.75 ± 19.37 [26].

The average mean deviation at baseline in our study was found to be -6.67 dB. Similar results were found by Leite MT, et al in their study. They found that the average mean deviation in glaucoma population was -5.6 dB [20]. Wu H, et al found the average VF mean deviation was -9.61 dB in glaucoma patients [27].

In our study Average baseline RNFL thickness in eyes showing >5 micron loss on OCT RNFL was 86.7 μ m whereas baseline RNFL thickness was 69.5 μ m in eyes which showed >1 dB decrease in mean deviation on perimetry only, suggesting that OCT is able to detect structural changes in early glaucomatous eyes as compared to functional changes in VF. Klamann MK, et al concluded that OCT could detect glaucomatous optic neuropathy prior to functional deterioration in SAP based on ONH and RNFL parameters [28]. Tenkumo K et al also concluded that the ability to detect glaucoma progression by SAP verses OCT is significantly influenced by the stage of disease [20]. In our study, positive moderate correlation was found between RNFL thickness and perimetric mean deviation and a negative correlation was found between RNFL and perimetric pattern standard deviation at each visit. The r values between RNFL and perimetric mean deviation were 0.56, 0.55, 0.52, 0.53 at 0, 6, 12 and 18 months respectively (P value < 0.01).

These are consistent with the correlation found by Wollstein G, et al in their study. They also found moderate correlation between RNFL thickness and the mean deviation and pattern standard deviation [25]. Kang EM et al the r value between the average RNFL thickness measured by SD OCT and

each VF severity index were 0.562, -0.514 , -0.577 , and -0.567 for the MD, PSD, CIGTS VF score, and AGIS VF score, respectively in glaucomatous eyes [29]. Mai Takagishi et al also found significant correlation between visual fields test points and RNFL sectors [30].

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