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ORIGINAL RESEARCH

Evaluating The Relation Between Retinal Nerve Fiber Layer (RNFL) Thickness And Visual Field Sensitivity in Primary Open Angle Glaucoma In Tertiary Health Care Center In Northern India

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ABSTRACT

Aim: To assess the relation between retinal nerve fiber layer (RNFL) thickness and visual field sensitivity in primary open angle glaucoma in tertiary health care center in northern India. **Material and Methods:** An observational cross-sectional study conducted involving the 50 patients with signs and symptoms of primary open angle glaucoma who attended the Outpatient Department of Ophthalmology at Maharishi Markandeshwar Deemed to be University, Mullana. To visualize the anterior chamber angle, gonioscopy was performed on each patient and the results were rated using the Schaffer grading method. All patients had the thickness of the RNFL assessed using the SD-OCT. Visual field defects were observed using the perimetry process and the correlation between RNFL thickness and visual field defect was examined. The level of significance was set at $p < 0.05$. **Results:** Male individuals made up 64% of the sample. The mean pattern standard deviation (PSD) for mild, moderate and severe POAG subjects was 3.79±2.42, 7.53±2.98 and 10.66±2.85, respectively. The RNFL thickness (μm) for participants with mild, moderate and severe POAG was 102.81, 83.67 and 62.95, respectively. **Conclusion:** There was a strong correlation between changes in the visual field and the RNFL thickness and optic disc characteristics in the POAG group. OCT can identify RNFL abnormalities in individuals suspected of having glaucoma whose disc and visual fields appear normal.

Keywords: Glaucoma, RNFL, OCT, SD-OCT

INTRODUCTION

The gradual degradation of retinal ganglion cells and their axons, which causes nerve fiber layer loss, optic disc cupping and subsequent glaucomatous visual field abnormalities, is the hallmark of glaucoma. Glaucoma is a type of progressive optic neuropathy that is characterised by elevated intraocular pressure (IOP), optic disc cupping and visual field loss [1-2]. In India, there are over 11.2 million glaucoma sufferers, of which 6.48 million have primary open-angle glaucoma (POAG) [3]. Only half of the estimated 67 million POAG patients globally receive their diagnosis in wealthy nations [4]. The identification rate of confirmed cases of POAG is even lower in poorer nations. The World Health Organisation estimates that nearly 105 million people are at risk of developing glaucoma [5]. The percentage of main angle-closure suspects (PACS) varied from 1.4% to 10.1% during the course of the investigation. The frequency of primary angle-closure suspected (PACS) individuals aged 40 and above was found to be 2.21% in the Andhra Pradesh Eye Disease Study (APEDS) [6].

Risk factors for primary open-angle glaucoma (POAG) include high intraocular pressure (IOP), low central corneal thickness, black African descent, family history of glaucoma, advanced age, myopia, Asian or Inuit descent, cardiovascular disease, vasculopathy and diabetes [7]. In cases of glaucoma, it is crucial to carefully examine the disc parameters, such as size, shape, neuroretinal rim shape and pallor; presence and location of splinter-shaped

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haemorrhages; occurrence, size, configuration and location of parapapillary chorioretinal atrophy and visibility of the RNFL [8].

Since the damage caused by glaucoma is mostly permanent, it is important to detect and treat glaucomatous damage as soon as possible. Retinal nerve fiber layer (RNFL) loss is thought to be an early indicator of glaucoma [9]. In order to identify and track the condition, examination of the peripapillary RNFL and optic nerve head (ONH) is crucial. The RNFL's optical characteristics have been used in recent imaging technology advancements to enable objective and quantitative measurement of the RNFL's thickness [10–11].

Because of its excellent picture resolution and measurement precision, spectral-domain optical coherence tomography, or SD-OCT, has quickly emerged as one of the most popular technologies in routine clinics. Several researches have explicitly focused on the association between structural and functional damage using SD-OCT, which has improved our ability to detect the presence and progression of glaucomatous damage. The findings of these investigations have indicated a strong link between the peripapillary RNFL and the global VF sensitivity. [12] Thus, the aim of the present investigation was to explore the correlation between the RNFL and VF measures and assess the applicability of these results in tracking the progression of early-stage glaucoma patients.

MATERIALS AND METHODS

The present observational cross-sectional study was conducted involving the patients with signs and symptoms of primary open angle glaucoma who attended the Outpatient Department of Ophthalmology at Maharishi Markandeshwar Deemed to be University, Mullana during January 2023-March 2024 (14 months). 50 patients visiting the tertiary care Centre meeting the inclusion criteria were part of the study.

Inclusion criteria

a) Patients clinically diagnosed cases of primary open angle glaucoma**.**
b) Patients of both genders of all ages with signs and symptoms of primary open angle glaucoma**.**
c) Patients who agreed to sign consent to participate in the study.

Exclusion criteria

a) Primary Angle closure glaucoma
b) Secondary open angle glaucoma
c) Secondary angle closure glaucoma
d) Congenital glaucoma
e) Patient not willing to be a part of study

Methods

A. A consent form in the patient's native tongue had to be signed before the patient could be admitted for the trial.
B. By employing a piloted proforma to gather patient data, the study's objectives were met through in-person interviews and clinical examinations of the patients.
C. The study only included patients who met the inclusion requirements.
D. Following the patient's selection for the study, a thorough clinical history was taken, encompassing the length of the complaint.
E. Following the acquisition of a comprehensive medical history, each patient underwent a comprehensive clinical examination in compliance with departmental protocols.
F. Snellen's chart was used to measure the patients' visual insight. The patient was first examined under a torch light and then a slit lamp was used for a more thorough examination.
G. All patients had their intraocular pressure measured using an applanation tonometer and their fundus was examined using both a direct and indirect ophthalmoscope in order to record the results.
H. To visualise angles, gonioscopy was performed on each patient and the results were rated using the Schaffer grading method.
I. All patients had SD OCT and the thickness of the RNFL was assessed (figure 1).
J. Visual field defects were observed throughout the perimetry process and the correlation between RNFL thickness and visual field defect was examined.

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Figure 1: OCT examination to check the RNFL thickness

Grading: The visual fields of MDs with >6 dB, >12 dB and >12 dB were classified as mild, moderate and severe glaucoma, respectively, according on the Hodapp, Parrish and Anderson categorization.

Statistical analysis: A statistician assisted in tabulating the data that was gathered in an Excel sheet. For statistical analysis, the means and standard deviations of each group's measurements were employed (SPSS 25.00 for Windows; SPSS Inc., Chicago, USA).Data were statistically analysed using one way ANOVA and the Tukey HSD post hoc test for each evaluation point. The level of significance for the Pearson correlation test, which was used to evaluate the correlation between two variables, was set at $p < 0.05$.

RESULTS

Males (64%) were comparatively more as compared to females (36%). The majority of participants (48%) belonged to the over-60 age group, with the remaining age groups (30%) and (18%) being 51-60 and 41-50 years old (table 1).

Table 1: Gender and age distribution among the study subjects

Gender	**N**	**%**
Male	32	64
Female	18	36
Age Group (in years)		
26-30	3	6
31-40	1	2
41-50	9	18
51-60	15	30
>60	22	48
Total	50	100

Mild, moderate and severe POAG was revealed in 24%, 22% and 54% of the subjects respectively (graph 1).

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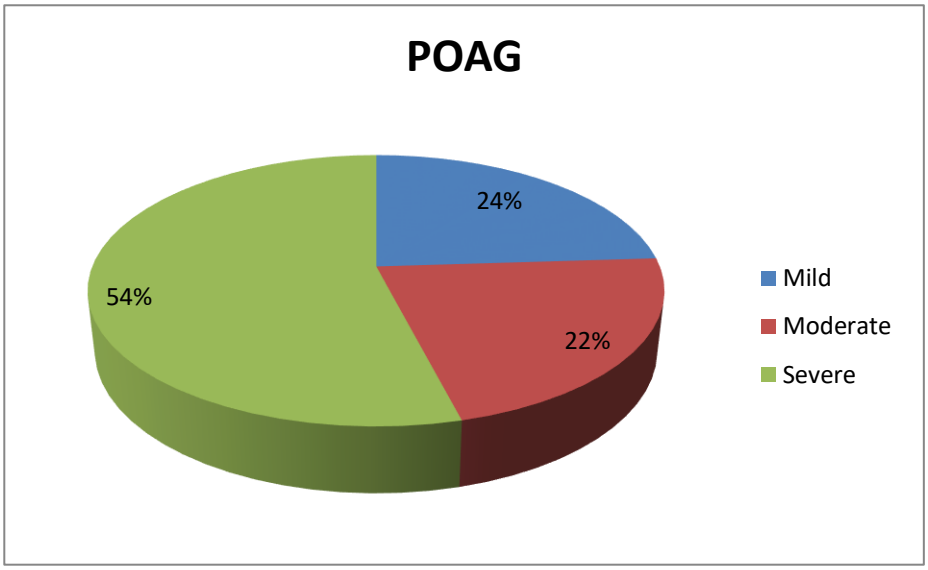

Graph 1: Type of POAG

Mean CDRV was found to be similar in mild and moderate POAG subjects while it was higher in severe POAG subjects with statistically significant difference (table 2).

Table 2: CDRV according to POAG

POAG	Mean CDRV	SD	p value
Mild	0.62	0.10	0.03*
Moderate	0.62	0.18	
Severe	0.71	0.16	
Total	0.63	0.15	

*: statistically significant

Mean IOP (mmhg) in mild, moderate and severe POAG subjects was 18.41±3.09, 19.56±4.37 and 19.98±4.61 respectively. Hence IOP increases with severity of POAG, though no significant difference was found as p>0.05. VFI% was found to be least in severe POAG subjects. Mean deviation (MD) was found to be deteriorated maximum in severe POAG followed by moderate and mild PAOG subjects with statistically significant difference which was p<0.05. PSD increases with severity of POAG with statistically significant difference as p<0.05. RNFL thickness (µm) was 102.81, 83.67 and 62.95 in mild, moderate and severe POAG subjects respectively. Hence RNFL thickness (µm) was found to be least in severe POAG subjects. When POAG severity was compared statistically according to RNFL thickness, significant difference was found as p<0.05 (table 3).

Table 3: IOP (mmhg), VFI (%), MD, PSD and RNFL according to POAG

POAG	Mean IOP	SD	p value
Mild	18.41	3.09	0.17
Moderate	19.56	4.37	
Severe	19.98	4.61	
POAG	**Mean VFI (%)**	**SD**	
Mild	93.54	8.13	<0.01*
Moderate	73.87	23.01	
Severe	48.32	16.77	
POAG	**Mean MD (dB)**	**SD**	
Mild	-2.69	1.08	<0.01*
Moderate	-7.43	3.19	
Severe	-19.02	5.61	
POAG	**Mean PSD (dB)**	**SD**	
Mild	3.79	2.42	<0.01*
Moderate	7.53	2.98	
Severe	10.66	2.85	
POAG	**Mean RNFL (µm)**	**SD**	

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Mild	102.81	7.04	<0.01*
Moderate	83.67	9.45	
Severe	62.95	8.73	

Significant negative correlation was found between VFI and RNFL as well as MD and RNFL while significant positive correlation was revealed between PSD and RNFL when analysed using Pearson correlation test (table 4).

Table 4: Correlation of VFI (%), MD, PSD with RNFL

Variables	r value	p value
VFI (%) and RNFL	-0.70	<0.01*
MD and RNFL	-0.62	<0.01*
PSD and RNFL	0.38	0.007*

*: statistically significant

DISCUSSION

POAG is a serious global health concern due to its progressive, silent character. It is among the main avoidable causes of blindness worldwide. Glaucoma can typically be detected and treated appropriately to stop its progression before it has a major negative impact on vision. For the purpose of diagnosis and treatment, it is crucial to examine and track the structural and functional health of the RNFL and the optic nerve head [12]. A non-invasive, non-contact method for determining the thickness of the retinal nerve fiber layer is optical coherence tomography. It offers possible ways to measure RNFL thickness as well as identify and record the development of RNFL loss. In order to diagnose glaucoma and determine the precise location and extent of visual field impairment, a thorough examination of the optic nerve head and RNFL is essential. When screening for glaucoma in high-risk individuals, OCT may be helpful [13]. The study's objective was to assess the relationship between visual field sensitivity and retinal nerve fiber layer (RNFL) thickness in cases with primary open angle glaucoma.

36% of the subjects were female, while 64% of the subjects were male. This study's male predominance can be explained by this. Similar male dominance was found in a study conducted by Preeti Chopra et al. [12] and C S Sandhya et al. [14].

The majority of participants (48%) belonged to the over-60 age group, with the remaining age groups (30%) and (18%) being 51-60 and 41-50 years old. This corresponds to 62.82 years in the study by Chinmayeepabouli et al. [15] Similar to the current study, C S Sandhya et al. [14] revealed that 50% of the study subjects were over 60, with a mean age of 60.

A statistically significant difference of $p<0.05$ was observed between the mean deviation (MD) of moderate and mild PAOG participants and the maximum mean deviation (MD) of severe POAG subjects. In their investigation, Latha C et al. [16] also discovered that the mean deviation in POAG was -15.49±8.26 (P value <0.001) and in suspects was -2.82±0.73. Yalvac et al. [17] examined 28 eyes in different glaucoma stages and contrasted the findings with 38 eyes of age- and gender-matched normal controls. In their investigation, the mean deviance was -13.79 ± 9.47 dB. A different study by Liu et al. [18] found that MD was −12.2 dB in 100 patients with open-angle glaucoma. Because we included a larger number of patients with severe glaucoma than any other study, our mean deviation was significantly higher than that of all the other studies. PSD and MD grew in tandem with the severity of glaucoma [18].

In participants with mild, moderate and severe POAG, the mean pattern standard deviation (PSD) was 3.79±2.42, 7.53±2.98 and 10.66±2.85, respectively. In light of this, PSD rises as POAG severity increases, with a statistically significant difference at $p<0.05$. In a similar vein, Latha C et al. [16] found that the pattern standard deviation was 7.75±2.80 in POAG and 2.20±0.65 in suspects.

RNFL thickness (um) for mild, moderate and severe POAG participants was 102.81, 83.67 and 62.95, respectively. Hence, it was discovered that severe POAG subjects had the least RNFL thickness (um). The statistical comparison of POAG severity based on RNFL thickness revealed a significant difference with a p-value of less than 0.05. The average RNFL thickness in suspects was found to be 83.51±2.83 and in POAG to be 66.81±13.51 (p value <0.001), according to a study by Latha C et al. [16]. This is consistent with the current research. According to a study by Badlani Vandana et al. [19], measuring the thickness of the retinal nerve fiber layer may help identify early nerve fiber loss due to glaucoma.

Likewise, CS In their study, Sandhya et al. [14] found that as glaucoma severity rose, there was a steady drop in both the mean and average RNFL thickness across all sectors. Although the difference between mild and moderate glaucoma was statistically significant only in the inferior and superior sectors, the sectoral RNFL thicknesses demonstrated a steady reduction. According to Yalvac et al. [17], the glaucoma group's average RNFL thickness was 62.90 ± 16.56 µm, while the control group's average was 111 ± 6.00 µm ($P<0.05$).

In a study of sixty glaucomatous eyes, Ahmed E. Abd El-Naby et al. [65] examined the thickness of the RNFL at different phases of the disease. The results of

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this study demonstrated a progressive drop in RNFL thickness from mild to severe glaucoma when comparing average RNFL thickness across different grades of the condition. Ahmed E. Abd El-Naby et al. made the same observation. Nouri Mahdavi et al. [20] and Leite et al. [21] have also published findings that are similar. In their work, Kaw et al. [22] compared the SD-OCT examination of RNFL thickness in normal controls and POA glaucoma patients at different stages. They discovered that, in contrast to patients with severe glaucoma, who had smaller RNFL, normal patients had the thickest RNFL thickness.

RNFL thickness was evaluated using SD-OCT in participants with POAG, NTG and normal subjects (Firat et al., 23). Normal patients had significantly higher RNFL thickness metrics, NTG and POAG in that order ($p < 0.05$). Therefore, in this study, the overall RNFL thickness was the most significant RNFL metric, followed by the RNFL thickness of the superior and inferior sectors.

When the Pearson correlation test was used to examine the data, substantial positive correlation was identified between PSD and RNFL and significant negative correlation between VFI and RNFL as well as MD and RNFL. The average RNFL was substantially linked ($r = 0.832$) with mean deviation, according to Latha C et al. [16]; this finding is consistent with the current investigation. Similar correlations between the variables were also found by Sandhya et al. [14] in their investigation. According to Preeti Chopra et al.'s study [12], there was a substantial link between RNFL thickness and VF indices in POAG patients, but not in glaucoma suspects.

This is consistent with a study by Sehi et al. [24] that examined the prospective detection of progressive RNFL atrophy in glaucoma suspects, preperimetric glaucoma patients and perimetric glaucoma patients using time-domain optical coherence tomography and visual field progression using standard automated perimetry. They discovered that in glaucoma-susceptible and glaucomatous eyes, structural advancement is linked to functional progression. Standard automated perimetry loss may be predicted by RNFL thickness, both superior and average.

CONCLUSION

There was a strong correlation between changes in the visual field and the RNFL thickness and optic disc characteristics in the POAG group. OCT can identify RNFL abnormalities in individuals suspected of having glaucoma whose disc and visual fields appear normal. It has been demonstrated that OCT can quantify RNFL thickness with accuracy and repeatability. In RNFL measurements, OCT has been demonstrated to have higher diagnostic accuracy. When it comes to glaucoma diagnosis, treatment, prognosis and research, OCT can be a helpful guide.

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