Original Research

Correlation Between Peripapillary Retinal Nerve Fiber Layer Thickness And Rim Area Using Spectral Domain Oct With The Humphrey Visual Field Indices In Eyes With Glaucoma And Normal Subjects- A Comparative Study

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ABSTRACT

Aim: To evaluate correlation between peripapillary retinal nerve fiber layer thickness (RNFL) and optic nerve head rim area (RA) measured using spectral domain optical coherence tomography (OCT) with visual field indices using Humphrey visual field analyzer in Glaucoma patients and normal subjects.

Methods: A prospective and observational study was conducted on 60 eyes of patients diagnosed with primary open angle glaucoma between the age group of 40-65 years and 60 eyes of age and gender matched healthy participants underwent ONH rim area analysis and peripapillary RNFL thickness measurements using spectral domain OCT and visual field indices determined using Humphrey perimetry. The study was conducted at the department of Glaucoma of a tertiary eye care hospital for a period of one year. The correlation of the average RNFL thickness and rim area with the Visual field indices was determined using the Spearman's correlation coefficient analysis and scatter plot.

Results: A total of 60 glaucomatous eyes and age –gender matched 60 healthy subjects were included in the study. There were 36 males and 24 females, with ages ranging from 45 to 60 years. In Glaucoma patients, average RNFL thickness, RA, mean deviation MD in decibels and VFI were 60.45 +/- 10.87 µm, 0.70+/-0.27 mm^2, -7.11+/-7.17 dB and 83.02 +/- 20.1 %, respectively. In normal subjects, average RNFL thickness, RA, mean deviation MD in decibels and VFI were 88.80+/-7.31 µm, 3.54+/-18.17 mm^2,0.05+/-1.53 dB, and 99.27+/-1.23%, respectively. there was significant difference in OCT and VF parameters between normal and glaucoma cases ($P<0.001$).In Glaucoma patients, the average RNFL thickness ($r = 0.236$) showed a stronger positive correlation with VFI than RA ($r = 0.143$), but the difference was not statistically significant.

Conclusion: In our study, the average RNFL thickness and rim area of the spectral-domain OCT demonstrated a positive correlation with the VFI of the Humphrey Visual Field Analyzer.Both structural and functional aspects should be evaluated in order to obtain full characterization of glaucomatous damage for clinical judgement and treatment.

Keywords: Rnfl Thickness, Rim Area, Sd-Oct, Glaucoma ,Visual Field Indices.

INTRODUCTION

Glaucoma is the leading cause of irreversible blindness worldwide and is associated with a reduced quality of life[1]. The number of people with glaucoma worldwide has surpassed 80 million, and number is estimated to reach 111.8 million by 2040[2].Primary open angle glaucoma is explicitly characterized as a "multifactorial optic neuropathy with a characteristic acquired loss of optic nerve fibers", developing in the presence of open anterior chamber angles and manifesting characteristic visual field abnormalities in the absence of other known causes of the disease[3]. Detection and monitoring of

glaucoma patients is based on recognition of structural and functional changes[4]. The spectral-domain optical coherence tomography (OCT) is currently being used in the diagnosis and assessment of structural changes in glaucomatous eyes and quantitatively measures the thickness of the peripapillary retinal nerve fiber layer and the optic nerve head (ONH) rim area (RA). The mean deviation from Humphrey perimetry is generally used to evaluate glaucoma progression. Since it can be affected by media opacity, a new functional index has been developed. The visual field index (VFI) is a new global metric that represents the entire visual field as a single number.

The Purpose of this study is to establish the correlation of the OCT parameters namely peripapillary retinal nerve fiber layer thickness and rim area value, with the visual field indices of Humphrey visual field analyzer.

MATERIALS AND METHODS

A prospective, comparative and observational study done on 60 eyes of glaucoma patients and 60 eyes of age-gender matched normal subjects attending Glaucoma services of tertiary care eye Hospital over a period of 1 year (January 2022- December 2022). An informed consent was taken before subjecting all cases and controls to required investigations. Participants underwent spectral domain OCT of optic nerve and Humphrey perimetry.

For the purpose of this study, glaucoma was defined as: (1) glaucomatous optic disc based on either cup/disc asymmetry between two eyes >0.2, rim defect, notching, excavation, or nerve fibre layer defect, and (2) two consecutive reliable abnormal HFA visual fields with corrected pattern standard deviation (CPSD) outside 95% normal limit, or GHT outside 99% normal limit, or three or more adjacent points with p <5% on the pattern deviation probability plot, and one of which must have p <1%[5]. Subjects were classified as having normal eyes if they had intraocular pressure <21mm Hg ,open angles on gonioscopy, normal appearing optic disc with healthy neuroretinal rim, no asymmetry in cup disc ratio between 2 eyes of more than 0.2 no evidence of peripapillary atrophy or ONH abnormality, normal fundus with no evidence of retinal or macular pathology, absence of visual field defects on 24-2 Sita Standard test with Humphrey visual field analyzer defined as mean deviation (MD) and pattern standard deviation (PSD) values within 95% confidence intervals, and glaucoma hemifield test classified as ‘‘within normal limits’’. Patients having substantial media opacity or any other retinal pathology and who underwent intraocular surgery or had ocular trauma and who doesn't give consent, patients with closed angle and secondary glaucomas were excluded from the study. The relationship between the average RNFL thickness and VFI, and optic nerve head rim area and VFI were analyzed using Spearman’s correlation coefficient, with a positive correlation being a value greater than 0. A value of $p \leq 0.05$ was considered statistically significant.

RESULTS

A total of 60 eyes of glaucoma patients and 60 eyes of age-gender matched normal subjects were included for analysis.The mean age of the participants was 55.37+/-6.29 years ranging from 45 to 60 years.60% were male (n=36) and 40% were female (n=24). In glaucoma patients,the mean average peripapillary RNFL thickness was 60.45+/-10.87 μm, ranging from 28 to 78 μm. The highest average peripapillary RNFL thickness (78μm) was observed in a 46 year-old female, and the thinnest (28μm) in a 52-year-old male. The mean average RNFL thickness for males and females (58.44+/-12.42 μm vs 63.46+/-7.26 μm; p = 0.08). The optic nerve head rim area ranged from 0.3 to 1.35 mm^2 with a mean of 0.70+/-0.27 mm^2. The mean rim area for males and females is statistically significant (0.64 +/-0.25 mm^2 vs. 0.79 ± 0.27 mm^2, p = 0.03). The largest rim area (1.35 mm^2) was observed in a 41 year-old male and the thinnest (0.3 mm^2) in a 63-year-old male. The visual field index ranged from 28 to 100 % with a mean of 83.02+/-20.13%. The mean VFI was significantly higher in females than in males (84.29+/-15.55 % vs 82.17+/-22.86%; p = 0.69). The highest VFI (100%) was observed in a 52-year-old female and the lowest (28%) was observed in 58 years old male.Mean MD in decibels in Glaucoma patients is -7.11+/-7.17 dB. In normal subjects, average RNFL thickness, RA, mean deviation MD in decibels and VFI were 88.80+/-7.31 μm, 3.54+/-18.17 mm^2,0.05+/-1.53 dB2, and 99.27+/-1.23%, respectively. there was significant difference in OCT and VF parameters between normal and glaucoma cases (P<0.001). Scatter plot showing the relationship between the average peripapillary RNFL thickness and VFI and the optic nerve head rim area with VFI are shown in Table 1 and Figures 1 and 2. In Glaucoma patients, a direct linear correlation was found for the average RNFL thickness and VFI (r = 0.236)(P value=0.07), and for the rim area and VFI (r = 0.143) (P value=0.27). The average RNFL thickness showed a greater correlation with the VFI than the rim area; however, this was not statistically significant. In Glaucoma patients,mean RNFL thickness had significant positive correlation with rim area (r=0.603) (P value=0.001) in Table 1 and Figure 3.

Table 1. Spearman's Correlation between RNFL thickness, Rim area and Visual field indices.		
	Normal (r) & P value	**Glaucoma(r) & P value**
Rim area vs.VFI	(-0.18) P=0.89	(0.143) P=0.27
RNFL vs. VFI	(-0.08) P=0.54	(0.236) P =0.07
RNFL vs. Rim area	(0.399 *P=0.002	(0.603) *P=0.001
MD vs. RNFL	(-0.20)P=0.11	(0.215) P=0.09
MD vs. Rim area	(-0.027)P=0.83	(0.133) P=0.31
*Value of P ≤ 0.05 is statistically significant. r = correlation coefficient		

Of the 60 Glaucomatous eyes tested, 8.3% (n = 5) had VFI between 0 and 33%, 6.7% (n = 4) between 34 and 66%, and 85% (n = 51) between 67 and 100%. Using Spearman's correlation coefficient, a positive correlation was established between RNFL thickness and VFI (r = 0.76) P=0.13, and between rim area and VFI (r = 0.87)P=0.54 in eyes with VFI values of 0-33% . Although the Rim area showed higher correlation coefficient with VFI than the RNFL thickness, the difference was not statistically significant . A positive correlation was also established for the RNFL thickness (r=0.79)P=0.58 and negative correlation was established for rim area(r=-0.91)P=0.52 with VFI in the 67-100% subgroup . The difference was also not statistically significant (p > 0.05).

Figure 1- Scatter plot shows Positive correlation between RNFL thickness (µm) and visual field index in glaucomatous eyes (Spearman's correlation coefficient R = 0.236 ;R^2 value is 0.088; Y = 0.55X + 49.84 and sig.2 tailed P value is 0.07).

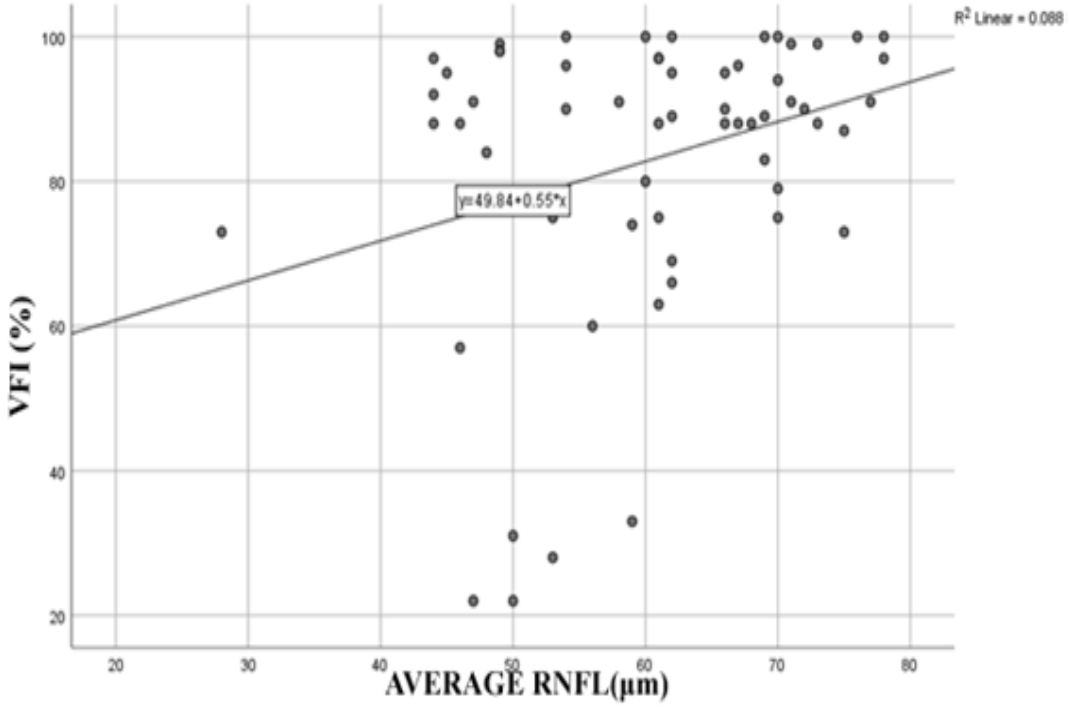


Figure 2- Scatter plot shows Positive correlation between Rim area (mm^2) and visual field index in glaucomatous eyes (Spearman's correlation coefficient R = 0.143 ;R^2 value is 0.072; Y = 19.88X + 69.09 and sig.2 tailed P value is 0.27).

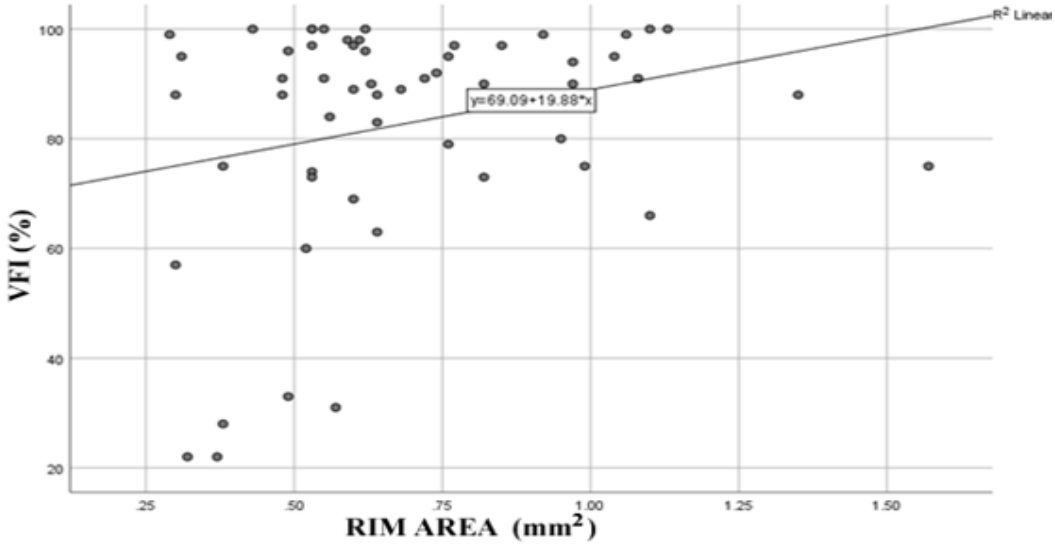
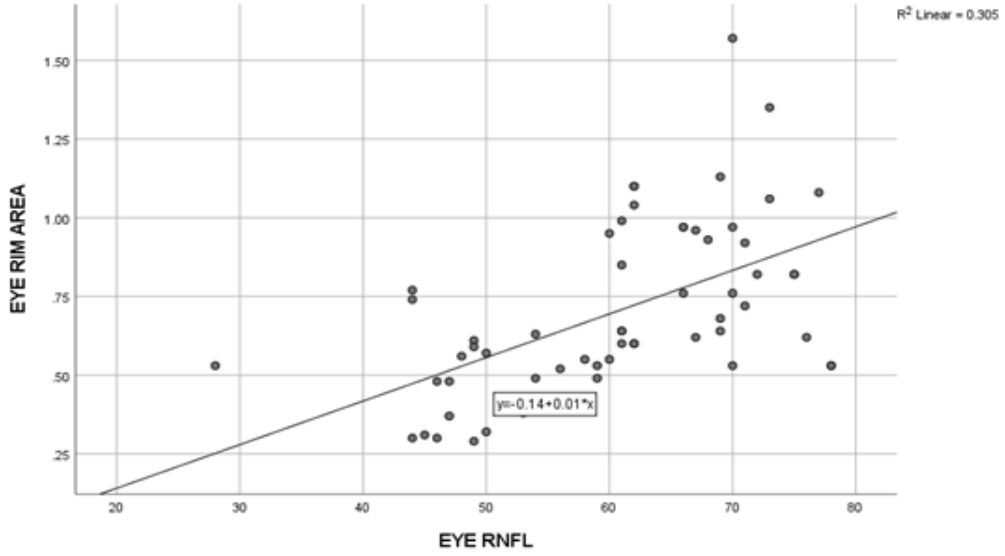


Figure 3- Scatter plot shows Positive correlation between RNFL thickness (µm) and Rim area (mm^2) in glaucomatous eyes (Spearman's correlation coefficient R = 0.603 ;R^2 value is 0.305; Y = 0.01X + 0.14 and sig.2 tailed P value is 0.001- statistically significant).



DISCUSSION

Previous reports have described the topographic and quantitative relation between the optic nerve head, RNFL, and visual field defects. Different studies revealed different parameters as having the strongest correlation with the visual field. Most of the studies emphasised the importance of cup/disc ratio[6], rim area[7] and RNFL thickness[6,8-9].The results from this study showed that in patients with glaucoma, the average RNFL thickness and the optic nerve head rim area obtained from the spectral-domain OCT demonstrated weak positive correlations with the visual field index obtained from standard automated perimetry of the Humphrey Visual FieldAnalyzer (Figures 1 and 2), similar to the findings of Sehi et al[10]. This indicates a weak structure-function relationship. Nilforushan et al[11] reported a higher correlation of rim area with VF thresholds compared to the RNFL.Our study, however,

showed similar findings, but it was not statistically significant (p >0.05). We found statistically significant positive correlation between average RNFL thickness and rim area (Figure 3) which can be explained by the fact that the neuroretinal rim of the ONH is intrapapillary ophthalmoscopic equivalent of the retinal nerve fibers. Though this study showed that, over-all, there was a correlation between the average RNFL thickness and rim area with the VFI, the correlation was not high. This was true especially for eyes with more significant visual field loss; in those with VFI of 0-33%, the Spearman's correlation coefficient was 0.76 and 0.87 for average RNFL thickness and rim area respectively. In earlier stages of glaucoma, the average RNFL thickness showed the highest correlation (r = 0.79), indicating that the OCT best predicts the VFI in earlier stages of the disease. On studying the correlation between Mean deviation (MD) in decibels (dB) and average RNFL thickness in Glaucomatous cases,Parisi et al[12] found significant positive correlation (r=0.393, P =0.03). Our study,however showed a positive correlation with MD (r=0.215, P=0.09) on standard white on white perimetry(24-2 Protocol) ,but it was not statistically significant(P>0.05). The limitation of this study was the relatively small sample that included glaucomatous eyes. Moreover, eyes with different co-morbidities that may decrease the VFI were also not excluded in this study. Other parameters, such as the cup-to-disc ratio and Hoddap classification, can be studied to further divide the eyes into subgroups.

CONCLUSION

The average peripapillary RNFL thickness and optic nerve head rim area measured by the spectral-domain OCT have positive correlations with the standard automated perimetry visual field index of the Humphrey Visual Field Analyzer. Although relations were found between some topographic parameters, RNFL parameters, and visual field indices, great interindividual variation limits the prediction of one parameter from the other. These OCT parameters are weak indicators for VFI, indicating weak structure-function relationships in many cases of glaucoma.Structural information provided by OCT and Functional information provided by Humphrey field analyzer are both important and complementary to each other.

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