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RESEARCH ARTICLE

STUDY OF CORRELATION OF OPTIC DISC CHANGES WITH VISUAL FIELD CHANGES AND RETINAL NERVE FIBER LAYER THICKNESS IN PRIMARY OPEN ANGLE GLAUCOMA

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Primary Open Angle Glaucoma, Rim Area, Average Cup/Disc Ratio, Vertical Cup/Disc Ratio, Mean Deviation, Pattern Standard Deviation, Visual Field Index, Retinal Nerve Fiber Layer Thickness

Abstract

Aim: To correlate the optic disc changes with visual field defects and with retinal nerve fiber layer thickness in patients diagnosed with primary open angle glaucoma for their accurate diagnosis and management.

Materials and Methods: This was a hospital based cross sectional study done on 100 eyes of 50 patients diagnosed with POAG who presented to Department of Ophthalmology from January 2021 to January 2022. A thorough clinical history and a complete ophthalmic examination including a detailed fundus examination was done. 24-2 SITA standard strategy Visual field recording was done on Humphrey visual field Analyzer.RNFL thickness is measured using Cirrus HD SD-OCT.

Results: There is statistically significant correlation of rim area with mean deviation(r=0.471), pattern standard deviation(r=-0.226), visual field index (r=0.486) and with RNFL thickness (r=0.476). Significant correlation is seen in vertical cup/disc ratio with mean deviation (r=-0.555), pattern standard deviation(r=0.207), visual field index(r=-0.559) and RNFL thickness (r=-0.511).

Conclusion: There is significant correlation of optic disc changes with visual field changes and also with RNFL thinning in POAG. Hence, in suspected cases of POAG both visual field testing as well as RNFL analysis must be undertaken for early and accurate diagnosis.

Introduction:-

Glaucomas are a diverse group of eye conditions that share the common feature of progressive optic neuropathy which may result in progressive visual field loss, with various risk factors that include but are not limited to increased intraocular pressure[1]. Glaucoma is the leading cause of irreversible blindness worldwide and is linked to a reduced quality of life[2]. The number of individuals with glaucoma was roughly calculated to be 76 million in 2020 and is expected to increase to 112 million by 2040[3].Glaucomas are divided into primary adult glaucomas which consists of open-angle and angle-closure glaucoma, secondary glaucomas due to a specific anomaly or disease of the

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eye, and congenital or developmental glaucomas[4]. Out of all, primary open angle glaucoma (POAG) is the most prevalent type. About 57.5 million people worldwide are estimated to be affected by POAG with a global prevalence of 2.2%[5].

The diagnosis and staging of glaucoma are done by structural and functional assessment[6]. The structural assessment is done by evaluation of the optic disc and the retinal nerve fiber layer whereas the functional assessment is done by visual field testing[6].The most popular method for estimating glaucomatous disc changes is vertical cup/disc ratio[7]. However, the detection of glaucoma based on vertical cup/disc ratio is limited due to its variability in normal population[5]. Mean deviation and pattern standard deviation are the global indices which give a numerical quantification of visual field loss[7]. However, the results are prone to being affected by the variability and subjectivity of the patient performing the test and in turn complicating the results and their interpretation[8]. It has been shown that damage to the RNFL precedes visual field loss[9]. Quigley et al.,[10] reported that up to 40% to 50% of the RNFL could be wiped out before visual field defects can be detected by conventional perimetry. Thus, RNFL assessment has emerged as an important parameter for preperimetric diagnosis of glaucoma.Hence, this study is undertaken with an aim to correlate the clinical findings of optic disc, the RNFL thickness and the findings of visual fields, which would help in accurate detection, in decision making about the management and the prognostication of primary open angle glaucoma.

Materials And Methods:-

This was a hospital based cross sectional study in which 100 eyes of 50 patients diagnosed with POAG presenting to the Department of Ophthalmology of a tertiary care hospital from January 2021 to January 2022 were included.Patients diagnosed with primary open angle glaucoma (POAG) of age >40 years and irrespective of sex were included in this study. Patients with any media opacities other than early lenticular sclerosis, closed angles on gonioscopy, diagnosed cases of secondary glaucomas, other diseases affecting visual field (E.g., pituitary lesions, demyelinating diseases etc.) and any other retinal lesions on fundoscopy (E.g., Diabetic Retinopathy, Vascular Occlusions etc.) were excluded from this study.

Institutional ethics committee approval was obtained before the start of the study. Written informed consent was obtained from each patient before inclusion into the study. A thorough clinical history was taken regarding chief complaint, duration of the disease and any other relevant history. A complete ophthalmic examination including visual acuity testing, slit lamp examination, Intra ocular pressure measurement using applanation tonometer, gonioscopy and a detailed fundus examination was done. Fundus photographs were taken with Zeiss fundus camera and Visual field recording was done on Humphrey visual field analyzer. The test strategy adopted was SITA standard and the test programme performed was central 24-2. RNFL thickness measurement was performed using the standard optic disc cube 200x200 scan protocol by Cirrus HD spectral-domain Optical coherence tomography system.

Statistical Analysis

The data was recorded in a specially designed proforma and is transferred to the master sheet. The analysis is done using MINITAB software version 18.0. ANOVA test as depicted by F-value and Pearson linear regression analysis as depicted by correlation coefficient r value were applied wherever appropriate.

Results:-

A total of 100 eyes of 50 POAG patients was included in the study. The mean age of the study population was 59.08 ± 8.96 years with 54% being males and 46% being females. The mean Intraocular Pressure (IOP) was 24.96± 2.792 mm of Hg.

The mean rim area of the study was 0.84±0.23mm^2 with the mean of average cup/disc ratio being 0.74±0.09 and the mean of vertical cup/disc ratio being 0.76 ± 0.07. The average Mean Deviation of the visual fieldswas –14.68 ± 8.45 dB with an average Pattern Standard Deviation of 7.01± 3.28 dB and the average Visual Field Index being 61.89 ± 28.21%.The mean average Retinal Nerve Fiber Layer (RNFL) thickness for all the eyes in this study was 63.35 ± 14.96 µm. The average superior RNFL thickness in this study was 79.36 ± 26.68 µm with the average inferior RNFL thickness being 70.05 ± 24.71 µm. The average temporal RNFL thickness was 46.90 ± 11.27 µm and the average nasal RNFL thickness was 55.03 ± 14.40 µm. The optic disc parameters- Rim area, Average cup/disc ratio and Vertical cup/disc ratio were correlated with visual field Parameters and RNFL thickness.

Correlation of Rim Area with Visual Field Parameters and RNFL thickness-

As evident in table 1, there is significant correlation between the rim area and the Visual field indices- Mean deviation (MD), Pattern Standard Deviation (PSD) and Visual Field index (VFI). Also, there is significant correlation between the rim area and RNFL thickness as depicted in table 2.

Table 1:- Correlation of Rim area with visual field Parameters.

Rim area Vs Visual field parameters	r-value	P-value	Significance
MD	0.471	<0.001	significant
PSD	-0.226	0.024	significant
VFI	0.486	<0.001	significant

Table 2:- correlation of rim area with RNFL thickness in all quadrants.

Rim area Vs RNFL thickness	r-value	P-value	Significance
Superior RNFL thickness	0.358	<0.001	significant
Inferior RNFL thickness	0.451	<0.001	significant
Temporal RNFL thickness	0.384	<0.001	significant
Nasal RNFL thickness	0.278	0.005	significant
Average RNFL thickness	0.476	<0.001	significant

Correlation of Average cup/disc ratio with Visual Field Parameters and RNFL thickness-

Correlation of average cup/disc ratio with MD and VFI is significant. Whereas, there is no correlation between average cup/disc ratio and PSD as described in table 3. Also, there is significant correlation of average cup/disc ratio and RNFL thickness (table 4).

Table 3:- Correlation of average Cup/Disc ratio with visual field parameters.

Average C/D ratio Vs visual field parameters	r-value	P-value	Significance
MD	-0.548	<0.001	significant
PSD	0.155	0.122	Not significant
VFI	-0.528	<0.001	significant

Table 4:- Correlation of average Cup/Disc ratio with RNFL thickness in all quadrants.

Average C/D ratio Vs RNFL thickness	r-value	P-value	Significance
Superior RNFL thickness	-0.517	<0.001	significant
Inferior RNFL thickness	-0.567	<0.001	significant
Temporal RNFL thickness	-0.519	<0.001	significant
Nasal RNFL thickness	-0.430	0.005	significant
Average RNFL thickness	-0.636	<0.001	significant

Correlation of Vertical cup/disc ratio with Visual Field Parameters and RNFL thickness-

There is significant correlation between Vertical cup/disc ratio and the visual field indices as outlined in table 5. Likewise, the correlation of Vertical cup/disc ratio and RNFL thickness is also significant (table 6).

Table 5:- Correlation of Vertical Cup/Disc ratio with visual field parameters.

Vertical C/D ratio Vs Visual field parameters	r-value	P-value	Significance
MD	-0.555	<0.001	significant
PSD	0.207	0.039	significant
VFI	-0.559	<0.001	significant

Table 6:- Correlation of vertical Cup/Disc ratio with RNFL thickness in all quadrants.

Vertical C/D ratio vs RNFL thickness	R-value	P-value	Significance
Superior RNFL thickness	-0.451	<0.001	significant
Inferior RNFL thickness	-0.448	<0.001	significant
Temporal RNFL thickness	-0.252	0.011	significant

Nasal RNFL thickness	-0.227	0.023	significant
Average RNFL thickness	-0.511	<0.001	significant

Discussion:-

In the current study, 100 eyes of 50 patients diagnosed with POAG were analyzed for optic disc changes, RNFL thickness and visual field defects. An attempt was made to correlate the optic disc changes (Rim area, Average cup/disc ratio, Vertical cup/disc ratio) with visual field indices (mean deviation, pattern standard deviation, visual field index) and retinal nerve fiber layer thickness in all quadrants.

The mean rim area of this study was 0.84 ± 0.23 mm^2 with the mean of average cup/disc ratio being 0.74 ± 0.09 and the mean of vertical cup/disc ratio being 0.76 ± 0.07. This is similar to a study byLatha C et al[11] which had a mean rim area of 0.89 ± 0.29 mm^2, themean of average cup/disc ratio being 0.72 ± 0.12 and a mean vertical cup/disc ratio of 0.78 ± 0.07.Similarly, in a study by Preethi Chopra et al[12] the mean of average cup/disc ratio was 0.77 ± 0.09 with the mean vertical cup/disc ratio being 0.75 ± 0.08.

In the current study, the average mean deviation was –14.68 ± 8.45 dB with the average pattern standard deviation being 7.01 ± 3.28 dB.This is comparable to studies byPasumarthy R et al [13](average mean deviation of -16.82 ± 9.619 dB, average pattern standard deviation of 5.72 ± 3.218 dB), by Preethi Chopra et al[12](average mean deviation of –15.44 ± 7.90 dB, average pattern standard deviation of 7.67 ± 2.96 dB) and by Latha C et al[11](average mean deviation of –15.49 ± 8.26 dB, average pattern standard deviation of 7.75 ± 2.80 dB).

The mean visual field index of the present study was 61.89 ± 28.21% which was lower than other studies conducted by Narayan S et al[14](76.06 ± 24.164%) and by Natalia A. Iutaka et al[6](88.4 ± 16.7%). This low value can be attributed to the inclusion of a greater number of patients from moderate and severe glaucoma groups attributing to this study being a hospital-based study.

The mean average RNFL thickness of the current study was 63.35 ± 14.96 µm. The average superior RNFL thickness was 79.36 ± 26.68 µm, average inferior RNFL thickness was 70.05 ± 24.71 µm, average temporal RNFL thickness was 46.90 ± 11.27 µm and the average nasal RNFL thickness was 55.03 ± 14.40 µm. This is similar to Latha C et al[11] (average RNFL thickness- 66.81 ± 13.51 µm, average superior RNFL thickness- 78.93 ± 26.2 µm, average inferior RNFL thickness- 76.90 ± 30.27 µm, average temporal RNFL thickness- 48.07 ± 14.16 µm, average nasal RNFL thickness- 59.40 ± 15.50 µm), and to Dr. Fahad Faiz et al[15](average RNFL thickness- 66.81 ± 13.51 µm, average superior RNFL thickness- 78.93 ± 26.20 µm, average inferior RNFL thickness- 76.90 ± 30.27 µm, average temporal RNFL thickness- 48.07 ± 14.16 µm, average nasal RNFL thickness- 59.40 ± 15.50 µm).

In the current study, there was significant correlation between rim area and mean deviation ($r=0.471$, $p<0.05$)which is in harmony to the other studies conducted by Lan Y et al[8]($r=0.325$, $p<0.05$) and Dagdelen K et al[16]($r=0.487$, $p<0.05$). similarly, there was significant correlation between rim area and pattern standard deviation ($r=-0.226$, $p<0.05$) similar to Lan Y et al[8] ($r=-0.25$, $p<0.05$) and Dagdelen K et al[16]($r=-0.443$, $p<0.05$). Also,significant correlationwas present between rim area and visual field index.

In accordance to the studies by Latha C et al[11]($r=-0.499$, $p<0.05$) and Preethi Chopra et al[12]($r=-0.623$, $p<0.05$), there was significant correlation of average cup/disc ratio and mean deviation in this study ($r=-0.716$, $p<0.05$). Correspondingly, there was significant correlation between average cup/disc ratio and visual field index ($r=-0.528$, $p<0.05$) similar to study by Natalia A. Iutaka et al[6]($r=-0.197$, $p<0.05$). However, there was no significant correlation between average cup/disc ratio and pattern standard deviation ($r=0.155$, $p>0.05$) which is in agreement to the studies by Lan Y et al[8]($p>0.05$) and Preethi Chopra et al[12]($r=0.256$, $p>0.05$).

Also, the present study concluded that there was significant correlation of vertical cup/disc ratio and mean deviation ($r=-0.555$, $p<0.05$) which corresponds to the result of studies by Narayan S et al[14]($r=0.639$, $p<0.05$) and Preethi Chopra et al[12]($r=0.623$, $p<0.05$). Likewise, there was significant correlation of vertical cup/disc ratio and pattern standard deviation($r=0.207$, $p<0.05$) similar to Narayan S et al[14]($r=0.585$, $p<0.05$) and Dagdelen K et al[16]($r=0.320$, $p<0.05$). Also, there was significant correlation of vertical cup/disc ratio and visual field index ($r=-0.559$, $p<0.05$) similar to Narayan S et al[14]($r=-0.624$, $p<0.05$).

In the present study, there was significant correlation ($p<0.05$) of rim area with superior RNFL thickness (r=0.358), inferior RNFL thickness (r=0.451), temporal RNFL thickness (r=0.384), nasal RNFL thickness (r=0.278) and average RNFL thickness (r=0.476) which is in accordance to study by Dr. Fahad Faiz et al[15]($p<0.05$). Likewise, there was significant correlation of average cup/disc ratio with superior RNFL thickness (r= -0.517), inferior RNFL thickness (r= -0.567), temporal RNFL thickness (r=-0.519), nasal RNFL thickness (r=-0.430) and average RNFL thickness (r=-0.636) which is in accordance to studies by Preethi Chopra et al[12] and Dr. Fahad Faiz et al[15]. Correspondingly, there was significant correlation ($p<0.05$)ofvertical cup/disc ratio with superior RNFL thickness (r=-0.451), inferior RNFL thickness (r=-0.448), temporal RNFL thickness (r=-0.252), nasal RNFL thickness (r=-0.227) and average RNFL thickness (r=-0.511) which is similar to studies by Preethi Chopra et al[12] and Dr. Fahad Faiz et al[15].

Conclusion:-

There is significant correlation between optic disc changes and visual field parameters, and between optic disc changes and RNFL thickness in POAG. There is positive correlation between rim area and mean deviation, between rim area and visual field index, and between rim area and RNFL thickness but a negative correlation between rim area and pattern standard deviation. Also, there is negative correlation of average cup/disc ratio with mean deviation, with visual field index, and with RNFL thickness. However, there is no correlation between average cup/disc ratio and pattern standard deviation. Similarly, there is negative correlation of vertical cup/disc ratio with mean deviation, with visual field index, and with RNFL thickness. There is positive correlation of vertical cup/disc ratio with pattern standard deviation. These findings can be an adjunct for early diagnosis, prognostication and the precise management of the disease.

Figures-

Figure 1: Multiple Scatterplots depicting Correlation of rim area with visual field parameters
Figure 2: Multiple Scatterplots depicting correlation of rim area with RNFL thickness in all quadrants
Figure 3: Multiple scatterplots depicting correlation of average C/D ratio with visual field parameters
Figure 4: Multiple scatterplots depicting correlation of average C/D ratio with RNFL thickness in all quadrants
Figure 5: Multiple scatterplots depicting correlation of Vertical C/D ratio with Visual field parameters
Figure 6: Multiple scatterplots depicting correlation of Vertical C/D ratio with RNFL thickness in all quadrants

Figure 1:-

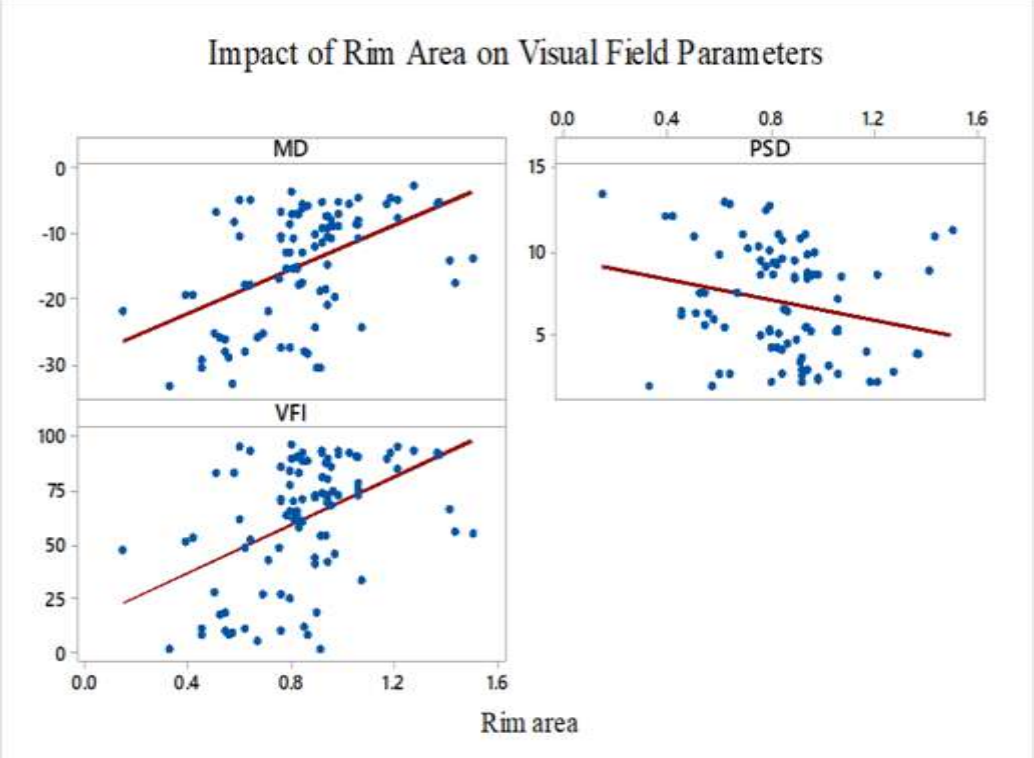


Figure 2:-

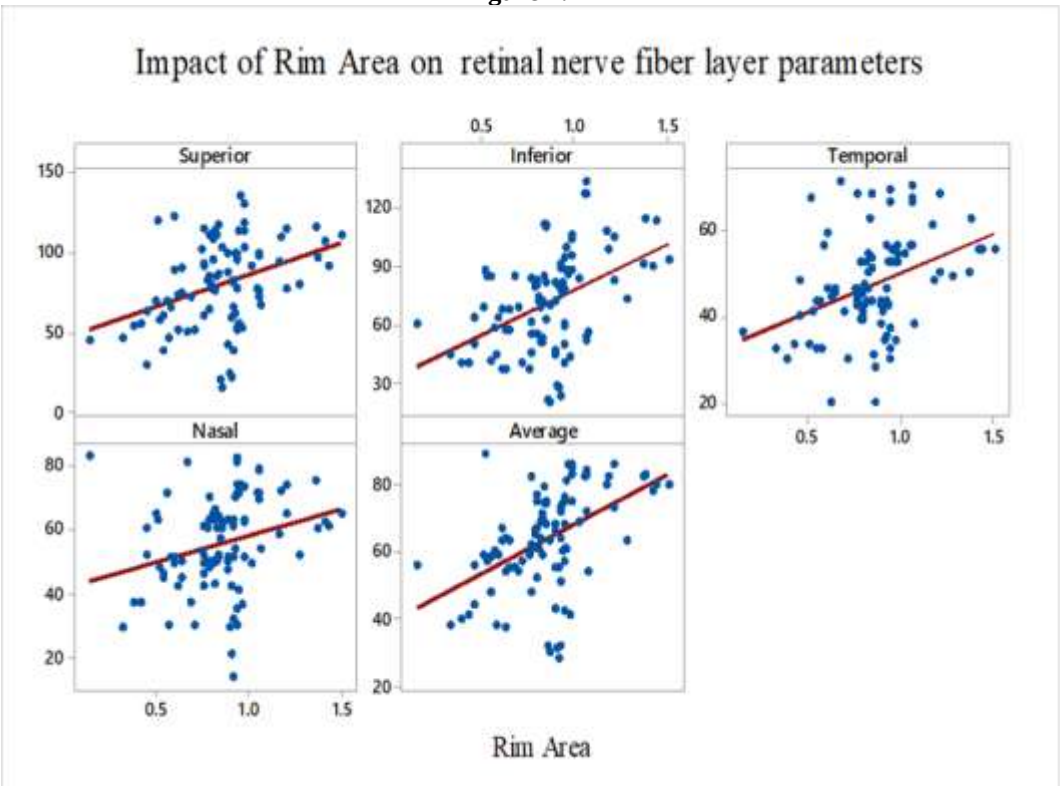


Figure 3:-

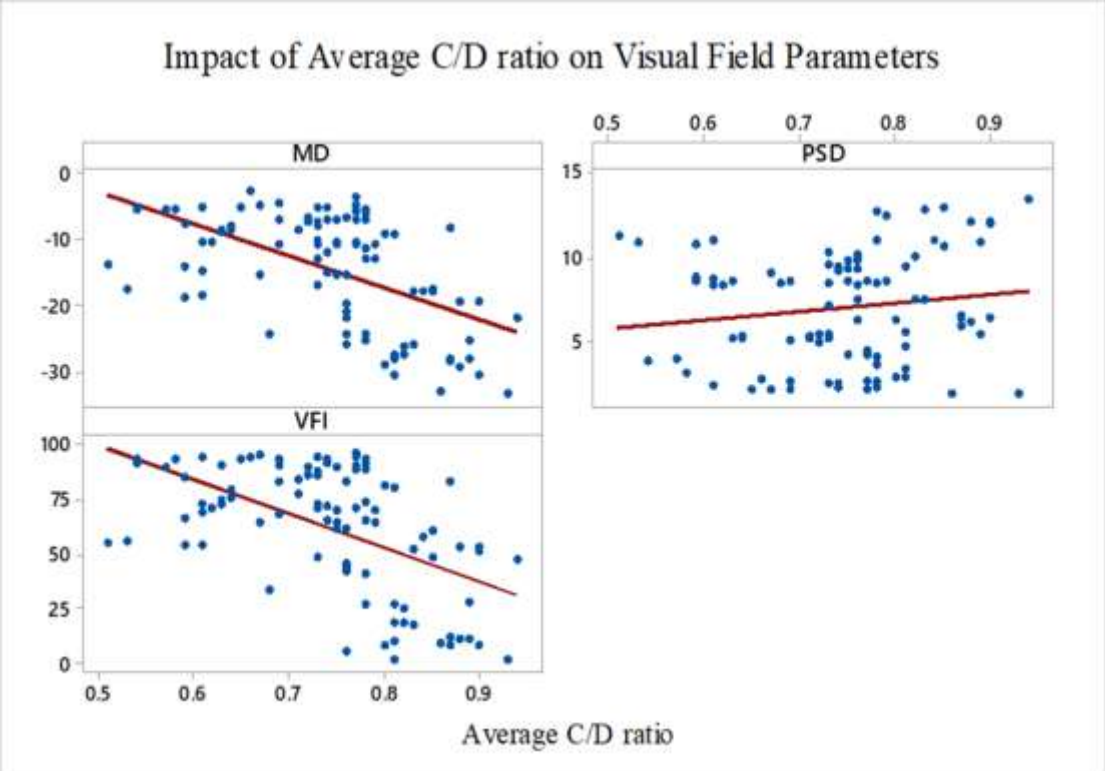


Figure 4:-

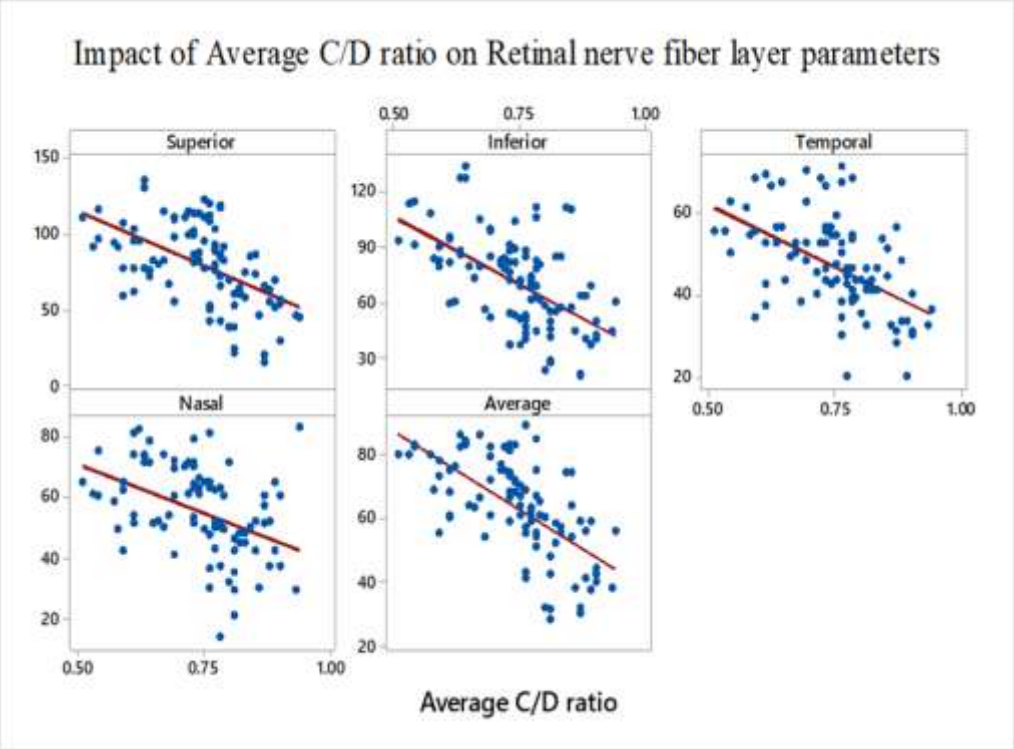


Figure 5:-

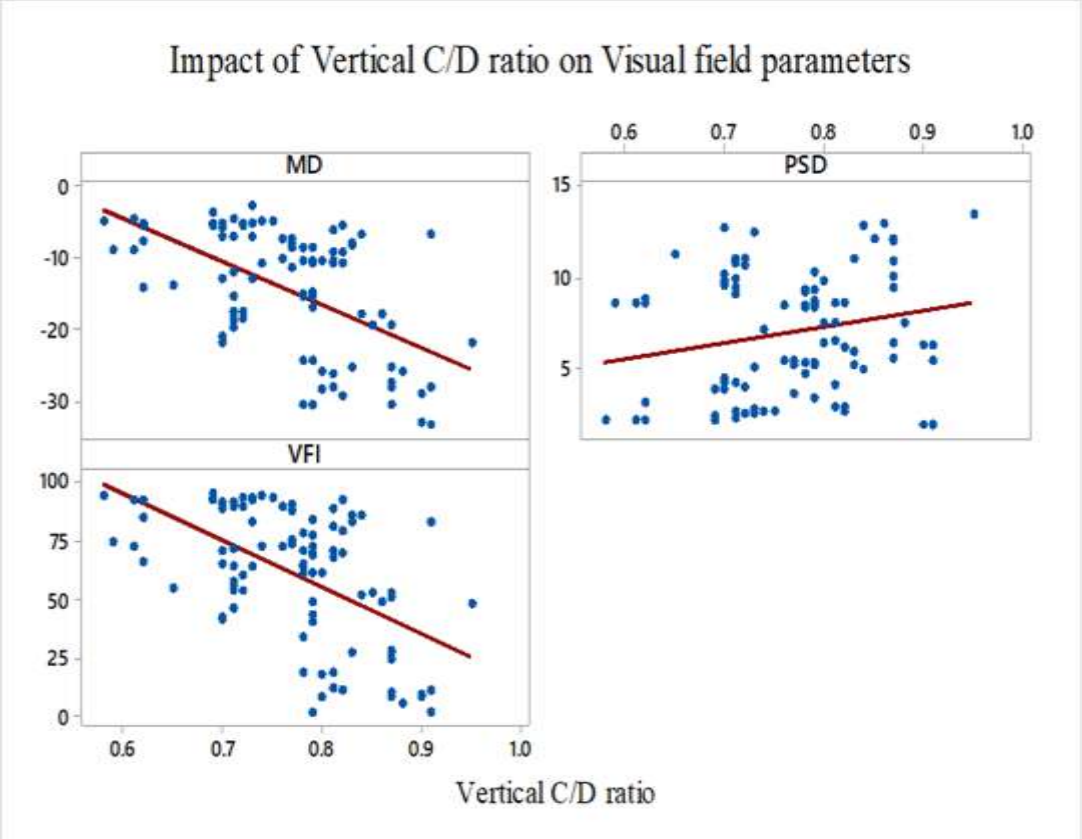
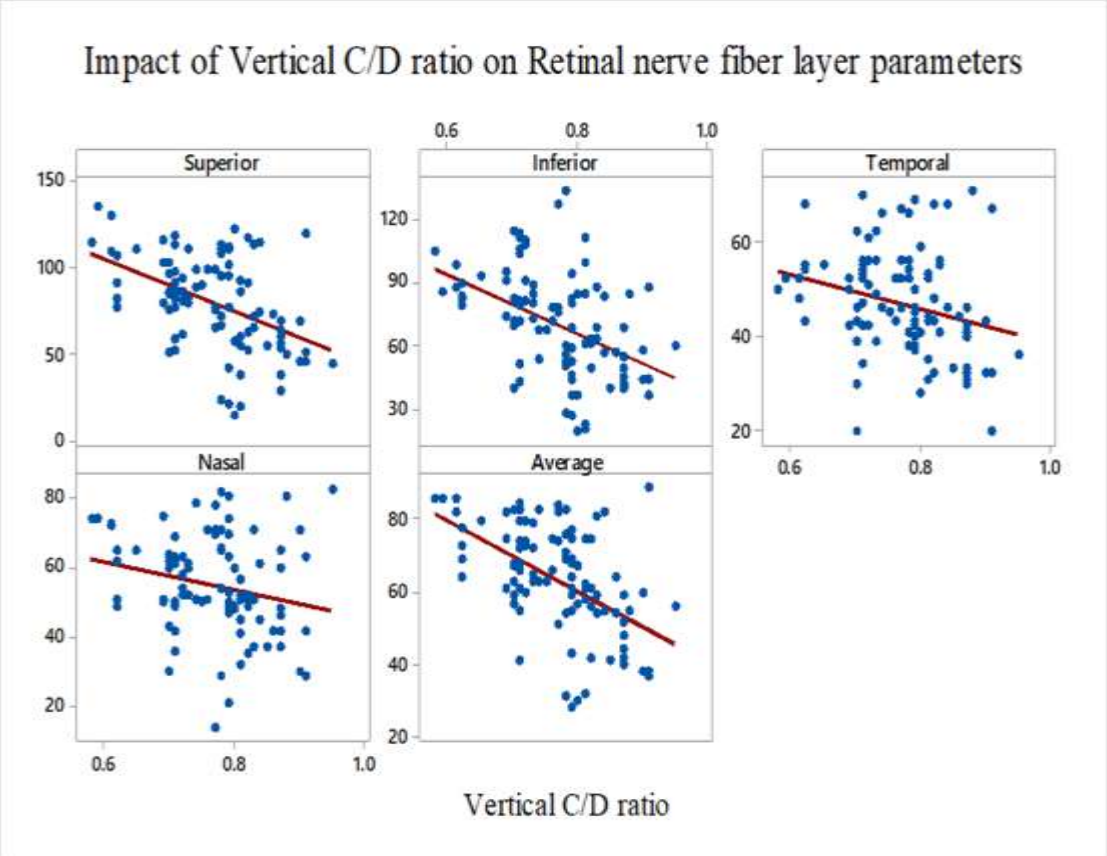


Figure 6:-



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