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CORRELATION OF GLOBAL INDICES BY AUTOMATED PERIMETRY AND RETINAL NERVE FIBRE LAYER THICKNESS BY OPTICAL COHERENCE TOMOGRAPHY IN SOUTH INDIAN PATIENTS WITH PRIMARY OPEN ANGLE GLAUCOMA

Ophthalmology

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ABSTRACT

A cross sectional study among established primary open angle glaucoma patients was conducted to study the correlation of global indices measured by automated perimetry and retinal nerve fibre layer(RNFL) thickness by optical coherence tomography(OCT). We noticed a statistically significant correlation ($p<0.00001$) between average RNFL thickness and mean deviation in both the eyes. Negative correlation was obtained between average RNFL thickness and pattern standard deviation but showed statistical significance ($P<0.00001$). The correlation between vertical cup-disc ratio and cup area volume in mm2 by OCT did not show any statistical significance to global indices. In established glaucomatous patients with visual field loss, a significant correlation exists between the global perimetric indices and the Total average RNFL thickness. The instruments like OCT are valuable tools to provide objective measurements of RNFL thickness and to give quantitative reproducible results; also interpretation of the structural tests is complementary to the subjective visual

KEYWORDS

Primary open angle glaucoma, Automated perimetry, Retinal nerve fibre layer thickness

INTRODUCTION

Glaucoma is a progressive optic neuropathy involving the optic nerve head (ONH) and retinal nerve fiber layer (RNFL) and is associated with visual field defects[1]. Automated static perimetry is a sensitive and specific test to analyze the functional loss of visual field, and it is gold standard to assess the disease progression and glaucomatous neuropathy; however, the chances of false positive and false negative reports are very high as it is a subjective test[2]. As per numerous studies, abnormalities in the glaucomatous field are usually preceded by structural changes of the ONH[3] and RNFL.

Primary open angle glaucoma(POAG) is characterized as a "multi-factorial optic neuropathy with a characteristic acquired loss of optic nerve fibres", developing in the presence of an open anterior chamber angles in gonioscopy and manifesting characteristic visual field abnormalities in the absence of other known causes of the disease. Newer technologies such as scanning laser polarimetry with fixed and variable corneal compensator, confocal scanning laser ophthalmoscopy, Optical coherence tomography (OCT) and retinal thickness analyzer have become available to obtain a reproducible quantitative and objective measurements of RFNL thickness[4]. As the Visual field test is considered to be gold standard for glaucoma diagnosis, all the above mentioned structure related investigatory modalities need to be compared with automated perimetry. The purpose of this study is to evaluate the relationship between structural changes by OCT and functional alteration by automated perimetry.

METHODS

Prospective cross sectional study done in consecutive POAG patients who attended the glaucoma clinic at a tertiary care hospital.

Inclusion criteria:

1. POAG patients with significant optic nerve head changes and visual field defects.
2. Patients who can co-operate for visual field testing.

Exclusion criteria:

1. Closed/narrow angles by Gonioscopy.
2. Secondary glaucoma.
3. Juvenile and congenital glaucoma.
4. Patients with media opacities.
5. Ocular pathologies other than POAG which could present with visual fieldchanges.

Patients who met the inclusion criteria were included in the study after signing an informed consent. After a detailed history, the subjects underwent a complete ophthalmic examination including gonioscopy, Intraocular pressure measurement using Goldmann Applanation tonometer, visual field testing using Humphrey based automated Perimetry (Appasamy Glaufield Lite) and RNFL analysis using Spectral Domain Optical coherence tomography (SD-OCT – NIDEK)

STATISTICAL SAMPLE SIZE CALCULATION:

Sample size calculation was based on primary objective of the Study- Correlation of visual field global indices (MD and PSD) by automated perimetry and RNFL thickness by OCT in POAG. From our experience and the available literature, the correlation coefficient between these two parameters were observed to be 0.5; with effect size of 0.4; with two tailed level of significance at 5.1 and power of 95%, Based on these calculations the minimum required sample size is 45 patients (90 eyes). Sample size derived based on software G* power 3.1.9.2

STASTICAL METHODS:

All the continuous variables were assessed for the normality using Shapero-Wilkie test. If the variables were normally distributed they were expressed as mean ± SD. All categorical variables were expressed as percentages. Comparison of continuous variables was done either by I-TEST or Mann-Whitney-U test based on normality pattern of data. Comparison of Categorical variables was done by chi-square test. Data entry was done in Excel spread sheet. Data analyzer and validation carried by SPSS version 16.0. P values less than 0.005 were considered as statistically significant.

RESULTS

95 eyes (46 right eyes and 49 left eyes) of 51 patients with age ranging from 30-74 years were analyzed. 44 patients had presented with bilateral POAG and 07 with unilateral disease. 60.8% (31) were males and 39.2% (20) were females. The mean age of the patients was 52 years (SD + 10.833). Analysis of correlation characteristics between the average RNFL thicknesses with visual field parameters revealed a statically significant strong correlation ($P<0.00001$).

Correlation of Mean Deviation and Total Average RNFL thickness:

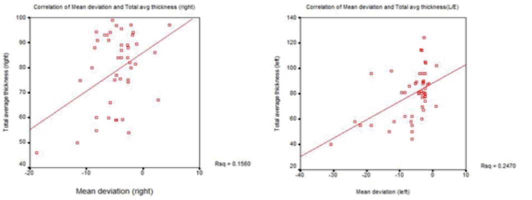

Fig-1: Correlation of Mean Deviation and Total Average RNFL thickness

A positive correlation was noted between total average RNFL thickness and mean deviation, Right eye r = (0.395) which is statically significant (P = 0.007); Left eye r = (0.497) which is statically significant (P = 0.000).

Correlation of Pattern Standard Deviation and Total average RNFL thickness:

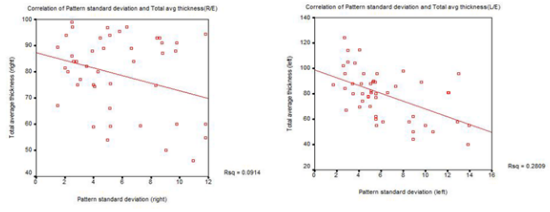

Fig-2: Correlation of Pattern Standard Deviation and Total average RNFL thickness

A negative correlation was noted between the average RNFL thickness and Pattern standard deviation, Right eye (r = - 0.302) (P = 0.041); left eye r = (-0.530) (P = 0.000) which is statically significant.

Correlation of Vertical C.D ratio and Mean Deviation:
There is a positive correlation between Vertical CD ratio and mean deviation in right eyes (0.063) which is not statistically significant (P=0.679); negative correlation between Vertical CD ratio and mean deviation in left eyes (-0.427) which is statistically significant (P=0.002).

Correlation of Cup Area Volume mm^2 and Mean Deviation:
A positive correlation was noted between cup area volume and mean deviation in right eyes (0.302) which is statistically significant. (P=0.041); left eyes (0.017) which is not statistically significant. (P=0.906).

Correlation of Superior Thinning of NRR with Inferior Visual Field Defects and Inferior Thinning of NRR with Superior Visual Field Defects:
Right Eye: Out of 46 right eyes 12 presented with superior NRR thinning with inferior visual field defects (including paracentral scotomas more on inferior field- 1 eye) and 34 eyes with inferior NRR thinning with superior visual field defects (including paracentral scotoma- 1 eye, nasal step- 1 eye and double arcuate scotoma more on superior field- 1 eye).

Left Eye: Out of 49 left eyes 11 presented with superior NRR thinning with inferior visual field defects (including paracentral scotomas more on inferior field- 1 eye) and 38 eyes with inferior NRR thinning with superior visual field defects (including paracentral scotoma- 1 eye, nasal step- 1 eye, and double arcuate scotomas more on superior field- 2 eyes).

Chi-square test shows a statically significant p value (0.000) in both eyes.

DISCUSSION

The first step towards glaucoma management, assessment of the amount of glaucomatous damage, is done by analyzing the structures affected (RNFL and Optic disc) with OCT and testing visual function with automated perimetry[5]. Certain parameters like measuring of RNFL thickness using OCT will help in detecting glaucoma even before the visual field loss[6]. It has been conveyed that RNFL thickness decreases in patients with glaucoma when compared with age-matched healthy patients[7]. This study was designed with an aim to evaluate the relationship between perimetric indices measured by automated perimetry and structural changes brought out by OCT.

In this study, statistically significant strong positive correlation (p<0.00001) was noted between average RNFL thickness and MD in both the eyes. While a negative correlation was obtained between average RNFL thickness and PSD but showed a statistical significance (P<0.00001) in both right and left eyes respectively. The correlation between the MD and RNFL thickness is found to be positive as against Octopus perimeters, because in Humphrey visual fields, a negative value indicates a depression or defect, while in the Octopus perimeters a positive value indicates defect. Similar results were showed by Sanchez- Galena et.al[8] and Hoh et al[9] who showed significant correlation between total RNFL thickness obtained from OCT and MD and PSD obtained from SAP.

Our study shows a statistically significant strong positive correlation between SD-OCT superior thinning of NRR with inferior glaucoma hemi field retinal sensitivity and inferior thinning of NRR with superior glaucoma hemi field retinal sensitivity (p < 0.000). This could possibly mean that the objective testing of RNFL characteristics could be complementary and supportive in making diagnosis of glaucomatous damage, along with the conventional visual field testing.

In this study, correlation between vertical cup disc ratio and cup area volume in mm^2 by SD-OCT did not show any statistical significance with global indices (MD and PSD). Hence it states that these parameters alone cannot be taken into account for the diagnosis of glaucoma. Also we noticed, a higher correlation between MD and a slightly lesser degree of correlation with parameters pertaining to PSD to total average OCT RNFL thickness by SD-OCT. The following reasons could be attributed to this:

a) The sample size is not representative of the general population, as only glaucomatous subjects were included. Co-relational studies are theoretically strong when the healthy and diseased subject populations are included, thereby enabling sampling of larger range of values than in glaucoma subjects alone.

b) Before the significant changes to be noted in the global parameter, certain amount of ONH and RNFL damage must take place. Therefore, comparison of global parameters with ONH and RNFL is important. Because that helps in better association between sectoral parameters and sectoral field sensitivities, as illustrated by case studies by Schuman et al[10] and Pieroth et al[11]. Finally, a large amount of normative database for the various investigative modalities is not currently available for the Indian population. In spite of above limitations; this study brings out statistically significant correlation and helps us to prove that the imaging instruments act as complementary measures for glaucomatous damage.

CONCLUSION

In established glaucomatous patients, a significant correlation exists between the global perimetric indices (MD and PSD) and the RNFL thickness. The MD was found to be better correlating with the average OCT RNFL thickness than that of PSD. A positive correlation exists between the superior and inferior NRR thinning and their corresponding inferior and superior hemi-fields sensitivity. Correlation between vertical CD ratio and cup area volume by SD-OCT did not show any statistical significance with global perimetric indices (MD and PSD). Hence showing that these parameters alone can not be taken into account for diagnosis of glaucoma. The instruments like OCT are valuable tools to provide objective measurements of RNFL thickness and to give quantitative reproducible results. Also interpretation of the structural tests is complementary to the subjective visual field testing.

REFERENCES

1. Lin, S. C., Singh, K., Jampel, H. D., Hodapp, E. A., Smith, S. D., Francis, B. A., … Minckler, D. S., American Academy of Ophthalmology, Ophthalmic Technology Assessment Committee Glaucoma Panel(2007). Optic nerve head and retinal nerve fiber layer analysis: a report by the American Academy of Ophthalmology. Ophthalmology, 114(10), 1937-49.doi: 10.1016/j.ophtha.2007.07.005.
2. Guedes, V., Schuman, J., Hertzmark, E., Wollstein, G., Correnti, A., & Mancini, R. et al.(2003). Optical coherence tomography measurement of macular and nerve fiber layer thickness in normal and glaucomatous human eyes. Ophthalmology, 110(1), 177-189. doi: 10.1016/s0161-6420(02)01564-63.

3. Sathyan, P & Anitha, S.(2012). Optical Coherence Tomography in Glaucoma. Journal of Current Glaucoma Practice. 6. 1-5. 10.5005/jp-journals-10008-1099.
4. Sani, R., Abdu, L., & Pam, V.(2016). Retinal nerve fiber layer thickness measurements of normal Northern Nigerian adults using optical coherence tomography. Annals Of African Medicine, 15(2), 52. doi: 10.4103/1596-3519.172557.
5. Ajtony, C., Balla, Z., Somoskeoy, S., & Kovacs, B.(2007). Relationship between Visual Field Sensitivity and Retinal Nerve Fiber Layer Thickness as Measured by Optical Coherence Tomography. Investigative Ophthalmology& Visual Science, 48(1), 258. doi: 10.1167/iovs.06-0410.
6. Bagga, H., & Greenfield, D.(2004). Quantitative assessment of structural damage in eyes with localized visual field abnormalities. American Journal Of Ophthalmology, 137(5), 797-805. doi: 10.1016/j.ajo.2003.11.060.
7. Medeiros, F.(2004). Comparison of the GDx VCC Scanning Laser Polarimeter, HRT II Confocal Scanning Laser Ophthalmoscope, and Stratus OCT Optical Coherence Tomograph for the Detection of Glaucoma. Archives Of Ophthalmology, 122(6), 827. doi: 10.1001/archopht.122.6.827.
8. Sánchez-Galeana, C., Bowd, C., Zangwill, L., Sample, P., &Weinreb, R.(2004). Short-wavelength automated perimetry results are correlated with optical coherence tomography retinal nerve fiber layer thickness measurements in glaucomatous eyes. Ophthalmology, 111(10), 1866-1872. doi: 10.1016/j.ophtha.2004.04.017.
9. Hoh, S., Greenfield, D., Mistlberger, A., Liebmann, J., Ishikawa, H., & Ritch, R.(2000). Optical coherence tomography and scanning laser polarimetry in normal, ocular hypertensive, and glaucomatous eyes. American Journal Of Ophthalmology, 129(2), 129-135. doi: 10.1016/s0002-9394(99)00294-9.
10. Schuman, J.(1995). Quantification of Nerve Fiber Layer Thickness in Normal and Glaucomatous Eyes Using Optical Coherence Tomography. Archives Of Ophthalmology, 113(5), 586. doi: 10.1001/archopht.1995.01100050054031.
11. Pieroth, L., Schuman, J., Hertzmark, E., Hee, M., Wilkins, J., & Coker, J. et al.(1999). Evaluation of focal defects of the nerve fiber layer using optical coherence tomography. Ophthalmology, 106(3), 570-579. doi: 10.1016/s0161-6420(99)90118-5.