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Research article

RELATIONSHIP BETWEEN THE RETINAL NERVE FIBRE LAYER (RNFL) PARAMETERS AND VISUAL FIELD LOSS IN ESTABLISHED GLAUCOMA PATIENTS IN SOUTH INDIAN POPULATION

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ABSTRACT

Purpose: Optical coherence tomography (OCT) and Scanning LASER polarimetry (GDX-VCC) are newer techniques to analyse retinal nerve fibre loss in glaucoma. This study aims to evaluate the relationship between the Retinal Nerve Fibre Layer(RNFL) parameters measured using Stratus-OCT and GDx-VCC and visual field loss by Octopus interzeag perimetry in established glaucoma patients in South Indian Population. **Materials and methods:** Prospectively planned cross sectional study of 67 eyes of 34 established glaucoma patients on medical management. The mean age of patients was 46.911 years (SD±13.531). A complete ophthalmic examination, automated perimetry with octopus interzeag 1-2-3 perimeter, retinal nerve fibre analysis with GDx VCC and Stratus OCT was done. The differences between the mean RNFL parameters in the presence or absence of field defects were evaluated. **Results:** The data analysed were mean deviation, loss variance, OCT total average nerve fibre thickness, GDX VCC- TSNIT average and Nerve fibre indicator (NFI).The data were split into two subgroups on the basis of presence or absence of visual field defect and analysed. The difference between the mean value of NFI between the subgroups was highly significant with a p value < 0.01.The OCT parameter Total average nerve fiber layer thickness differed significantly between the two subgroups (p value ≤0.05). The mean GDx TSNIT average did not differ significantly between the two subgroups. **Conclusion:** The total average nerve fibre thickness by OCT correlated better with visual field loss than the GDX TSNIT average .Among the GDx parameters, the NFI was found to be a better indicator of visual field damage than the average thickness.

Key words: Retinal nerve fibre analysis, OCT, GDX-VCC

INTRODUCTION

Glaucoma is a disease which is associated with progressive damage to the optic nerve and retinal nerve fibre layer [1]. Visual field loss in glaucoma is due to structural damage and it is documented by automated perimetry . However, the results of perimetry are variable as the test is subjective[2]. Up to 40 percent of the RNFL may be lost before a defect is apparent on the visual fields [3,4].

Various studies have shown that structural changes of the optic nerve head[5-7] and nerve fibre layer[4,8-11] appear before the visual field changes.

The optic nerve head and RNFL changes over time were studied by stereoscopic photographic images. Though they provide objective information for comparisons, the interpretation of photographs remains subjective, and variations in assessment among even experienced observers are well documented[11-13].

Furthermore, qualitative assessment of photographs may not be sensitive to small changes over time, and it is difficult to pick up diffuse damage on these photographs. Newer technologies such as confocal scanning laser ophthalmoscopy (HRT), retinal thickness analyser (RTA), scanning laser polarimetry with fixed and variable corneal compensator (GDxVCC), optical coherence tomography (OCT) have become available that provide quantitative reproducible, and objective measurements of RNFL thickness.

As visual field assessment has been considered as the gold standard for glaucoma diagnosis, all structure based investigatory modalities need to compare with automated perimetry. The purpose of this study is to evaluate the relationship between structural changes evaluated by OCT and GDX VCC and visual field defects in established glaucomatous eyes.

MATERIALS AND METHODS

This was a cross sectional study, prospectively planned. 67 eyes of 34 glaucoma patients attending glaucoma clinic were included in this study after ethical committee clearance. Informed consent was obtained from all the patients.

Inclusion criteria:

1. Established primary open angle glaucoma patients (open angles>2 by Shaffer's grading on gonioscopy) on medical treatment and routine follow up were chosen for the study. The patients were diagnosed as glaucomatous by the following criteria: at least three or more occasions of elevated intra ocular pressure >21 mm Hg now on medical control and significant optic nerve head changes with or without visual field defects.
2. Refractive errors : Hyperopia ≤ +2.50D , Myopia ≤ -3.00 D , Astigmatism<+2.00 D
3. Best corrected visual acuity 6/ 12 or better
4. Pupil size 3.0-5.0 mm
5. Relative intelligence to understand the test and patients co-operative for visual field analysis.

Exclusion criteria:

1. Closed angles /narrow angles by gonioscopy
2. All patients who had secondary glaucomas, juvenile and congenital glaucomas, media opacities, retinal and neurological pathologies.
3. Primary open angle glaucoma patients who undergone surgical or laser therapy for glaucoma

All subjects underwent a complete ophthalmologic examination including refraction, Slit lamp biomicroscopy for anterior segment evaluation and fundus examination with +90 D lens, gonioscopy, Intra ocular pressure measurement using Goldmann applanation tonometry and also direct ophthalmoscopy. Glaucomatous appearance of the Optic disc was defined as an increased C: D ratio, asymmetry of the C: D ratio of >0.2 between the two eyes, Neuro retinal rim thinning disc haemorrhage, notching and excavation.

Visual field analysis was performed with Octopus Interzeag1-2-3 perimeter. The tendency oriented perimetry strategy was used An abnormal visual field was defined as: Field plotting with mean deviation > 4, Loss variance > 6 , a local dip in the Bebie's curve outside 2 SD normal limits, Points of depressed sensitivity especially in the arcuate areas, paracentral areas , nasal step region or advanced tubular fields. All fields were reliable with false positive and false negative catch trials < 15%.

RNFL analysis was performed by OCT and GDX VCC. All scans were performed by trained technicians who were unaware of the patient's diagnosis.

RNFL analysis with Optical coherence tomography: Retinal nerve fibre layer measurements were obtained with Stratus OCT (Zeiss) version 4.0.1. All scans were performed by well trained technicians who were masked to the patient diagnosis and characteristics. For each patient three 3.4 mm diameter circular scans were obtained, judged to be of acceptable quality and averaged by trained technicians to provide mean measurements of RNFL thickness.

RNFL analysis with GDX VCC: The GDX VCC (Version 5.2.3) is a scanning laser polarimeter that measures RNFL thickness using polarized light. The placement of the ellipse on the disc margin for the scan was done by the same technician.

All scans were performed by the same well trained technician. The disc margin on the image was established with an ellipse whose parameters were adjusted by the experienced technician who was masked to the patient diagnosis and characteristics. All these investigating modalities were carried out within a period of 3 weeks to obtain the best cross sectional comparison and to nullify the effect of any temporal lag.

Statistical analysis: statistical analysis carried out using SPSS™ software. Student's t test was used to derive the significance of the difference between the means.

RESULTS

67 eyes of 34 established Primary open angle glaucoma patients were analysed in this study. The mean age of the patients in this study was 46.911 years (SD±13. 531) .The ages of these patients ranged from 26 to 70 years. Out of the 34 patients, 10 patients were females accounting for about 29.41%. The global visual field indices obtained from octopus perimetry were mean defect (MD) and loss variance (LV). The mean MD for our group of patients was 5.140±5.853 and the mean LV was 22.551± 20.79**.** The Retinal nerve fibre layer thickness was analysed by Optical coherence tomography .The parameter which was studied was the Total average nerve fibre layer thickness (OCT T Avg). The GDX VCC RNFL analysis parameters studied were the TSNIT average (TSNIT Avg) and the nerve fibre indicator (GDX NFI). (Table:1)

Table: 1. Analysis of the visual field indices obtained from octopus perimetry (mean defect (MD) and loss variance (LV)and OCT and GDX VCC parameters in the 67 study eyes:

Parameter	Primary open angle glaucoma (N=67)		
	Mean± SD	Min	Max
MD	5.140 ±5.85	-1.4	24.9
LV	22.551±20.79	1.8	88.4
OCT Total average thickness(microns)	87.74±22.21	20	129
GDX-VCC TSNIT average thickness (microns)	48.216± 9.02	24.160	64.710
GDX-VCC Nerve fibre indicator	32.463± 25.36	9	98

Table 2: Analysis of the RNFL parameters on the basis of presence or absence of visual field loss:

Parameter	Group		Significance of difference between the means (*Students t Test*) P value
	Normal fields	Abnormal fields	
	Mean ±SD	Mean±SD	
MD	-0.10±0.90	6.28±5.85	0.000**
LV	3.48±1.32	26.71± 20.73	0.000**
OCTT Avg (microns)	96.92±11.95	85.75± 23.48	0.023*
GDXTSNIT(microns)	51.18±5.10	47.57±9.59	0.075***
NFI	21.08±8.63	34.95±27.13	0.003**

r = Pearsons correlation coefficient; p =p value , *p≤0.05 (0.01 to 0.05) –significant at 5% level
** p≤ 0.01- significant at 1% level, *** p> 0.05 – not significant at 5% level

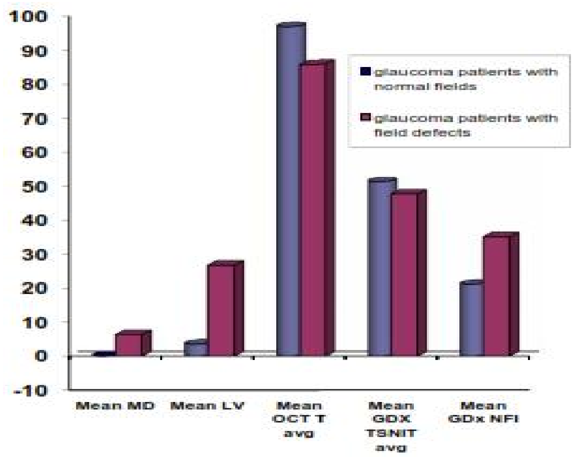

Fig 1: Bar chart showing the difference between the mean values among the two subgroups

Analysis on the basis of presence or absence of visual field loss: (Table:2, Figure1): The data was split on the basis of presence or absence of visual field loss and analysed. Out of the 67 eyes, 12 eyes did not show any field defect whereas the rest had a significant visual field loss.

Statistically significant difference (p ≤0.05 (0.01 to 0.05) –significant at 5% level) was obtained for the OCT Total average thickness (96.92 um ±11.95 in the normal field group and 85.75 um±23.48 in the group with abnormal field)

When the GDX parameter, TSNIT average was analysed, no significant difference was appreciated between the two subgroups (51.18±5.10 in the normal field subgroup and 47.57±9.59 in the other subgroup; p value= 0.075 (p > 0.05 – not significant at 5% level).

Significant difference was obtained (p≤ 0.01) between the two subgroups for the GDx parameter, NFI (21.08 ±8.63 in the normal field subgroup and 34.95±27.13 in the subgroup with field changes; the p value obtained was 0.003).

DISCUSSION

This study was designed with the objective to determine the relationship between the results obtained by these two methods(OCT and GDX VCC) for quantitatively assessing the RNFL and visual field defects by autoperimetry in established glaucomatous eyes in south Indian population.

The primary strength of this study is that the instruments were compared in a single population. The advantage of examining the performance of these instruments in a single population is that population characteristic based variables are eliminated, thus allowing direct comparison of the results obtained with the different instruments.

Limitations of this study include a small number of subjects. Another limitation, inherent in any comparable study is that different diagnostic techniques evaluated in this study are currently at different stages of development. In general, established technologies benefit from robust normative databases and more sophisticated analysis strategies. Also, different techniques may identify different characteristics of glaucomatous damage.

Various studies have demonstrated good diagnostic accuracy with different modalities of imaging in glaucoma[14-19]. Good comparability of OCT and GDX has been demonstrated by many studies in various stages of glaucoma[20-24]

The data were split into two subgroups on the basis of presence or absence of visual field defect and analysed (table: 4). A gross difference was observed between the mean values of MD, LV, OCT T Avg , TSNIT Avg, and NFI in the two subgroups. The difference between the mean values of M D and LV and NFI were highly significant with a p value < 0.01- significant at 1% level. Also, the OCT parameter, Total average nerve fiber layer thickness differed significantly between the two subgroups (p value $\leq$0.05– significant at 5% level).

The mean GDx TSNIT average did not differ significantly between the two subgroups. These data could suggest that while using the GDx the NFI is a higher predictor of visual field damage, than the GDX TSNIT average thickness. Also, among the Total average nerve fibre layer thickness measured by OCT and GDx (TSNIT average), the OCT parameter seems to correlate better with visual field damage than the GDx parameter.

Studies by Kanamori et al have shown that visual field defect has a strong correlation with OCT total average thickness[25].

Reus et al [26] reported that GDx-VCC correlated well with mild to moderate visual field loss in glaucoma patients.

Our data demonstrated that patients with advanced field defects have a greater RNFL loss. Also, for a specific value of visual field index there was a large range of RNFL values. Two explanations can be reasoned out for this: one is the variability of the RNFL values among the normal population and the other reason may be the amount of RNFL damage required for the field loss may vary among different patients. This problem has been mentioned by other studies also[27]. The influence of variability among patients can be overcome by conducting a longitudinal analysis.

This is a Pilot study carried out in an attempt to establish the relationship between the Visual field indices and RNFL parameters in glaucoma patients in our south Indian population. This study brings out statistically significant correlations in spite of the above limitations. This finding validates both techniques as indicators of glaucomatous damage. A similar study, if undertaken, with a larger sample with inclusion of the normal population as age matched controls and carried out longitudinally would possibly make the results much more specific. Also, inclusion of glaucoma suspects, ocular hypertensives and early glaucoma patients in subsequent trials would serve to establish the utility of these newer diagnostic technologies in glaucoma management and research.

Outcomes of the study:

1. The total average nerve fibre thickness by OCT correlated better with visual field loss than The GDX TSNIT average.
2. Among the GDx parameters, the NFI was found to be a better indicator of visual field damage than the average thickness.

CONCLUSION

Though visual field testing is subjective, at present it cannot be replaced by imaging modalities. The new instruments are valuable tools that have become available to provide quantitative reproducible and objective measurements of RNFL thickness.

Structural information provided by the OCT and GDx and functional information provided by the field analysis are both important and complementary to each other

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