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Original Article

Can ganglion cell complex assessment on cirrus HD OCT aid in detection of early glaucoma?

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Abstract

Context: Ganglion cell complex is damaged early in glaucoma. Does this loss of GCC help in early diagnosis of glaucoma.
Aims: To compare the RNFL thickness and ganglion cell complex (GCC) in diagnosed patients of glaucoma, pre-perimetric glaucoma and normal controls.
Settings and design: Case controlled, observational study.
Methods and material: 33 glaucoma patients, 45 pre-perimetric glaucoma, and 30 controls were enrolled in the study. ONH parameters on cirrus HD OCT like CD ratio, para papillary RNFL thickness and GCC were calculated for each case.
Statistical analysis used: ANOVA test to analyse differences between groups. ROC for ganglion cell layer.
Results: RNFL thickness was 71.6 μ and GCC was 69.19 μ in glaucoma patients. RNFL thickness was 77.31 μ and GCC was 71 μ in pre-perimetric glaucoma and 99.6 μ and 85.16 μ in controls respectively. The difference of mean for RNFL and GCC by ANOVA was statistically significant for controls, glaucoma patients and pre-perimetric glaucoma patients. RNFL ($p < 0.001$) and GCC ($p < 0.001$). Receiver operating characteristic curve for GCC was 0.83 ($p < 0.000$).
Conclusions: The RNFL analysis is increasingly being used as newer tool in diagnosis of glaucoma. In addition, GCC can be used as a supplementary tool in picking up cases of pre-perimetric glaucoma as loss is significant in pre-perimetric glaucoma also.

Keywords: Ganglion cell complex, Optical coherence tomography, Retinal nerve fibre layer, Glaucoma

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Introduction

Glaucoma is a chronic progressive optic neuropathy with high intra-ocular pressure (IOP) as one of the important risk factors. Apart from IOP, vascular insufficiency and other cellular factors have a definite role to play. The final common pathway is cupping of optic nerve head due to death of ganglion cell axons. The death of axons is associated and may be by ganglion cell death. The characteristic changes of the nerve head (ONH) and visual field defects on perimetry confirm the diagnosis of glaucoma. The loss of retinal ganglion cells is considered as an important step in pathogenesis in cascade of events leading to retinal nerve fibre (RNFL) loss and changes of optic nerve head. Various modalities for diagnosis of glaucoma have been used but the search for the ideal modality for early diagnosis remains elusive.[1] Newer perimetric methods were launched with great enthusiasm but they seem to have a limited role to play. For visual field defects to be evident on white on white perimetry, it requires at least 30–40% of neuronal cell loss to occur which is irreversible. The problem is confounded by the fact that the patient is also not aware of the problem.[1]

Use of Optical Coherence Tomography (OCT) in the diagnosis and follow up of glaucoma has gained universal

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acceptability in recent years. It can give very accurate parameters for optic nerve head assessment along with the retinal nerve fibre layer analysis.[2] Even so, early diagnosis remains a challenge and requires correlation with other factors. Recent studies on the use of OCT in glaucoma have explored the ability of this technology to detect the loss of ganglion cell complex (GCC). The ganglion cell complex is studied by the OCT which has the maximum density at the macula. Roughly, one lac ganglion cells are found in the human retina and half of this number is centred on the fovea. This anatomic arrangement suggests that a macula scan with GCC analysis could be early indicator of this disease.[3]

This prospective observational study was designed to study the role of GCC in early diagnosis of glaucoma.

Materials and methods

The Study was conducted at a tertiary care teaching centre between Aug 2012 and Jul 2013 on Asian patients. Institutional ethical clearance was taken and tenants of declaration of Helensiki were adhered to. Participants were given detailed information and consent was taken. IOP was corrected to central corneal thickness wherever required (Average corneal thickness was taken as 530 μm. For pachymetry values above this one mm Hg was reduced for every 14 μm and one mm Hg was added for every 14 μm for values lower than normal). IOP was recorded after wash off period of the drug wherever indicated: 45 pre-perimetric glaucoma patients (IOP > 21 mmHg, with optic nerve head changes or RNFL defects and normal Visual fields) and 33 glaucoma patients (IOP > 21 mmHg, with optic nerve head changes or RNFL defects correlating with visual field changes). 30 normal controls with IOP < 21 mmHg without evidence of glaucomatous optic neuropathy and RNFL defects with negative family history of glaucoma were enrolled in the study. Patients with poor vision and media opacity which hampered OCT examination were excluded. Patients with other retinal or macular pathologies like diabetic retinopathy, retinal vein occlusion, high refractive errors (> +/−6 DS) were excluded from the study. Cases of angle closure glaucoma, traumatic glaucoma and other secondary glaucoma were excluded from study.

All patients were subjected to comprehensive ophthalmic evaluation which included visual acuity, anterior segment examination including pupillary reaction, anterior chamber angle assessment by gonioscopy, intra-ocular pressure measurement by Goldmann applanation tonometry, slit lamp biomicroscopy, pachymetry, visual field testing (Oculus twin field) and Optical Coherence Tomography (Zeiss cirrus HD OCT). Visual field testing was done within three months of OCT. Second reliable field was analysed as per Anderson's criteria for all patients.

Single well trained examiner did OCT after pupillary dilatation. Optic nerve head scans were acquired with 4 mm concentric maps. The GCC maps were based on macular protocol centred on fovea with a cube of 512 × 128 with automated measurement of GCC and internal limiting membrane. OCT scans with signal strength more than 6 were included for analysis.

ONH parameters on cirrus HD OCT like CD ratio, para papillary RNFL thickness and GCC were calculated for each case. One eye of each patient was randomized to be part of analysis.

The results were collected on Microsoft excel (Office 2013) and analysed using SPSS (Version 17 IBM NY) software using ANOVA. The means were compared and a p value < 0.05 was considered significant. Area under the curve for GCC was also calculated.

Results

Results: A total 108 patients were enrolled in the study. The mean age of glaucoma patients was 58.54 (SD 13.78) years, pre-perimetric glaucoma was 53.71 (SD 17.553) years and controls was 52 (SD 14.88). In the glaucoma group, 54.54% were males and 45.45% were females. In the pre-perimetric glaucoma group, 46.66% were males and 53.33% were females and in control group 53.33% were males and 46.66% were females.

The data showed a normal distribution. The difference of mean for RNFL and GCC by ANOVA was statistically significant for controls, glaucoma patients and pre-perimetric glaucoma group RNFL ($p < 0.001$) and GCC ($p < 0.001$). When comparing the difference of means of GCC and RNFL with normal values, it was found to be statistically significant ($p < 0.001$) and GCC ($p < 0.001$) (Table 1).

Pearson correlation coefficient for ganglion cell layer had a statistically significant correlation ($r = 0.455$) with the RNFL thickness ($p < 0.05$).

Receiver operating characteristics curves for GCC were drawn as shown in Fig 1. The area under the curve (AUC) 0.835 with 95% Confidence interval 0.751–0.899 which was statistically significant ($p < 0.0001$)

Table 1. Comparative OCT data for study group.

Diag		CDR	RNFL	GCC
Control	Mean	.4907	99.6000	85.1667
	N	30	30	30
	Std. deviation	.11380	10.32773	9.07092
	95% CONF interval	0.44–0.53	95.74–103.45	81.77–88.55
Poag	Mean	.6876	71.6364	69.1970
	N	33	33	33
	Std. deviation	.12150	20.15110	12.72113
	95% CONF Interval	0.64–0.73	64.49–78.78	64.68–73.70
Pre-perimetric	Mean	.6716	77.3111	71.8556
	N	45	45	45
	Std. deviation	.091870	17.07313	10.70929
	95% CONF Interval	.64–0.69	72.18–82.44	68.63–75.07

Comparative data.