Assessing the Importance of Ganglion Cell Complex (GCC) in Diagnosing Preperimetric Glaucoma

Dr. Rohan Dedhia[1], Dr. Vaidehi Sathaye[2], Dr. Nita Shanbhag[3]

[1, 2] MBBS, Resident Ophthalmologist, Dr. DY Patil Medical College, Navi Mumbai, India

[3] MS, Professor and HOD, Department of Ophthalmology, Dr. DY Patil Medical College, Navi Mumbai, India

Abstract: *Glaucoma is a multi factorial optic neuropathy characterised by retinal ganglion cell loss and eventually loss of retinal nerve fibers causing visual impairment.* <u>*Purpose*</u>*: To map GCC thickness and average Macular Retinal thickness with Spectral Domain Optical Coherence Tomography and compare it with Retinal Nerve fiber layer thickness in 38 eyes with preperimetric glaucoma.* <u>*Result*</u>*: GCC loss correlated well with the loss of average RNFL thickness and MR thickness.* <u>*Conclusion*</u>*: GCC analysis may prove to be a robust diagnostic parameter and is complementary to RNFL analysis in preperimetric glaucoma.*

Keywords: Preperimetric-Glaucoma, OCT, GCC, RNFL

1. Introduction

Glaucoma is a multi-factorial optic neuropathy characterized by a loss of retinal ganglion cells with subsequent loss of the retinal nerve fibers ultimately resulting in visual impairment. It is the leading cause of irreversible blindness and second leading cause of blindness worldwide. (1)

There are approximately 11.2 million people aged 40 years and older with glaucoma in India and primary open angle glaucoma is estimated to affect 6.48 million persons.(2)

Importance of GCC at Macula
The macular region contains a high concentration of more than 50% of RGCs, which can be quantified relatively easily compared to peripheral RGCs that may be too thin for OCT to measure reliably.(3)

In addition, the macular region is the primary location of glaucomatous damage in the disease's early stage. Since glaucoma affects mainly the inner layers of the retina, Ganglion Cell Complex (GCC) mapping can help to detect glaucomatous damage early as compared to the total retinal thickness.

Figure 1 : Ganglion Cell Complex Anatomy

Preperimetric glaucoma (PPG) is defined as the presence of characteristic glaucomatous changes in the optic disc and increased vulnerability to damage in the retinal nerve fiber layer (RNFL), without the presence of visual field defects detectable with standard automated perimetry.(4)

2. Literature

Currently Glaucoma is diagnosed at the perimetric stage. And though standard white on white perimetry has been considered the gold standard in documenting damage and monitoring progression, 50% of the retinal nerve fiber layer may be lost before a visual field defect is apparent on Perimetry.(5)

When correlating retinal ganglion cell atrophy with automated perimetry in glaucoma patients, 20% loss of cells, especially large ganglion cells in the central 30% of the retina, correlated with a 5-dB sensitivity loss on Perimetry. 40% loss corresponded with a 10-dB decrease. 10% or fewer axons may remain by the stage of severe field loss.(6)

The purpose of this study is to assess GCC thickness and average Macular Retinal (MR) thickness with the Cirrus High-Definition (HD) OCT and correlate it with the Retinal Nerve fiber layer (RNFL) thickness in preperimetric glaucoma.

Popular Spectral Domain OCTs today
1) Cirrus High-Definition (HD) OCT (Carl Zeiss Meditec, Inc., Dublin, CA),
2) RTVue-100 (Optovue Inc., Fremont, CA),
3) Spectralis SD OCT (Heidelberg Engineering Inc., Heidelberg, Germany), and
4) 3D OCT-1000 and 3D OCT-2000 (Topcon Corporation, Tokyo, Japan).

Components of GCC measured among commonly used Spectral Domain OCTs:
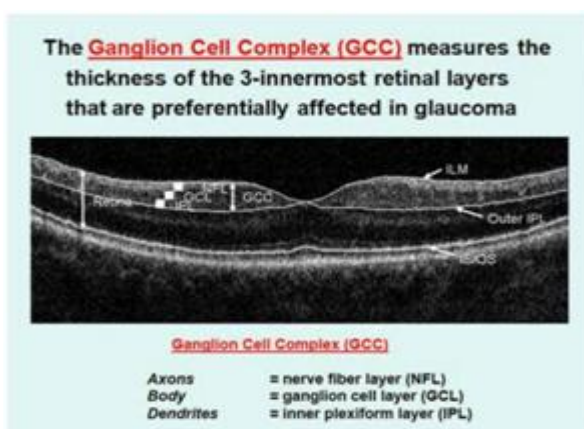1) Cirrus: GCL+IPL
2) Optovue: GCL+IPL+RNFL

3) Spectralis
By Default GCC: GCL+IPL+RNFL Automated Segmentation Algorithm

3. Methods

38 eyes of 25 patients diagnosed as preperimetric glaucoma were studied.
Age: 48 +/- 12 years
Male 62% Female 38%
Mean IOP 20+/- 4 mmHg
CCT 544 +/- 36 microns

Inclusion criteria
Consecutive patients reporting for routine evaluation and diagnosed as preperimetric glaucoma on the basis of:
1) Baseline dilated fundus examination:
   - Cup Disc (CD) ratio >0.5 with,
   - vertical cup-to-disc ratio greater than the fellow eye by >0.2,
   - diffuse or localized rim thinning,
   - dischemorrhage
   - notch in the rim detected
2) Intraocular pressure ≥21 mmHg
3) Perimetry: Normal Humphrey Swedish Interactive Threshold Algorithm (SITA) 30-2 standard Visual Field

Exclusion criteria
1) Patients already diagnosed as glaucoma and on treatment for glaucoma
2) Diabetic retinopathy or other diseases that could cause visual field loss or optic disc abnormalities
3) History of chronic ocular or systemic corticosteroid use

All Patients underwent:
1) A complete anterior segment evaluation
2) Intraocular pressure measurement using Goldman Applanation tonometer
3) Gonioscopy using 2 mirror gonioscope
4) Optic disc evaluation using 90 Dioptre(D) lens
5) Perimetry using the Humphrey's Perimeter (30-2 SITA Standard)
6) OCT using the Cirrus High-Definition OCT (Carl Zeiss Meditec): RNFL thickness, MR thickness,GCC thickness map. (Scans with Signal Strength <5 were rejected.)

GCC, MR thickness and RNFL thickness was mapped using the Cirrus High-Definition (HD) OCT (Carl Zeiss Meditec, Inc., Dublin, CA). Average GCC thickness and MR thickness were correlated with the RNFL thickness.

4. Results

Average GCC of patients was 85.99 ± 6.9 μm. There was GCC loss in 33eyes(86.84%) which correlated well with areas of RNFL loss (r=0.408, p<0.001).

6eyes (15.78%) were seen to have decreased MR thickness. Further GCC loss was also seen in 26 eyes (68.42%) with a normal MR thickness.
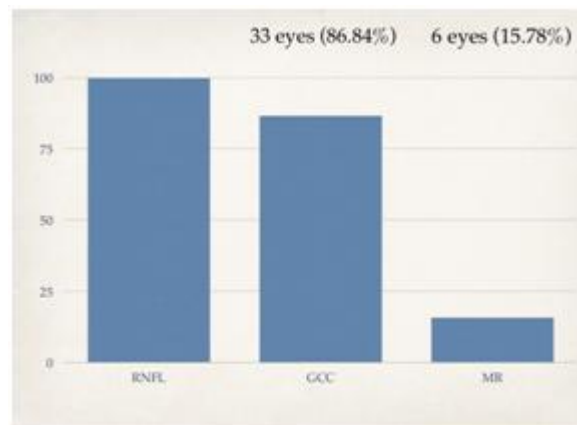
Figure 2: Bar Chart representing the average thickness in microns of RNFL, GCC, MR

Figure 3: The Glaucoma Continuum

5. Conclusion

The diagnosis of glaucoma can often be difficult, especially in the very early stages when structural damage and functional changes are not obvious.

This has the potential both for:
- Missed diagnosis leading to failure to treat glaucoma or
- A waste of expensive and potentially harmful treatment on individuals who do not have glaucoma.
- And thus, GCC mapping can be considered a surrogate to RNFL loss in preperimetric glaucoma.

6. Future Scope

As mentioned earlier, there are approximately 11.2 million people aged 40 years and older with glaucoma in India and primary open angle glaucoma is estimated to affect 6.48 million persons.(2)

Considering that this is the second leading cause of blindness after Cataract, it is of great importance to diagnose it at a stage where early detection and intervention may change the natural course of the disease.

References

[1] Robert LS, Mark FL, Michael VD. Becker-Shaffer's diagnosis and therapy of the glaucomas. 8th ed. Mosby: Elsevier; 2009. pp. 175– 178.
[2] George R, Ve RS, Vijaya L. Glaucoma in India: estimated burden of disease. J Glaucoma. 2010 Aug;19(6):391–397. [PubMed]

[3] Sung MS, Yoon JH, Park SW. Diagnostic validity of macular ganglion cell-inner plexiform layer thickness deviation map algorithm using cirrus HD-OCT in preperimetric and early glaucoma. J Glaucoma. 2014;23(8):e144-151.

[4] Weinreb RN, Aung T, Medeiros FA. The pathophysiology and treatment of glaucoma: a review. *JAMA*. 2014; 311: 1901– 1911. [PMC free article] [PubMed]

[5] Quigley H, Green W, Addicks E. Optic nerve damage in human glaucoma. III. Quantitative correlation of nerve fiber loss and visual field defect in glaucoma, ischemic neuropathy, papilledema, and toxic neuropathy. Arch Ophthalmol. 1982 Jan;100(1):135–146. [PubMed]

[6] Quigley HA, Dunkelberger GR, Green WR. Retinal ganglion cell atrophy correlated with automated perimetry in human eyes with glaucoma. Am J Ophthalmol. 1989 May 15;107(5):453–464.

Author Profile

Dr. Rohan Dedhia, MBBS, Resident Ophthalmologist, Dr. DY Patil Medical College, Navi Mumbai