ORIGINAL ARTICLE

Role of Optical Coherence Tomography in Early Diagnosis of Open Angle Glaucoma: An Experience

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ABSTRACT

Objective: To evaluate role of cirrus high definition optical coherence tomography (HD-OCT) in early diagnosis of glaucoma by measuring optic nerve head (ONH), retinal nerve fiber layer (RNFL) and ganglion cell complex (GCC) analysis.

Subjects & Methods: The cross sectional study was conducted at Ch. Rehmat Ali Hospital Lahore from March 2014 to September 2015. A total 115 patients were enrolled in study, comprises two groups; A) Diagnosed Glaucoma patients and B) Glaucoma suspect (Pre Perimetric Glaucoma) Second group further divided in 1) ocular hypertension 2) enlarged physiological cup. All patients underwent comprehensive ophthalmic exam, BCVA, IOP, using Goldman applanation tonometer. Anterior segment examination on slit lamp, Gonioscopy and OCT on cirrus HD-OCT spectralis machine.

Results: Out of 115 patients 65 (56%) were male, 50 (44%) were female. Mean age 43.7(SD±10.3) years. On OCT analysis patients with Glaucoma and ocular hypertension shows superior as well as inferior hemisphere defects 63.33% and 36.66% respectively. While 80% showed GCC defects. Ocular hypertensive 56% (14 eyes) showed RNFL defects, 20% show GCC deviation. Patients with enlarged cup show 26.66% changes in RNFL, while 13.33% shows GCC changes.

Conclusion: SD-OCT of Optic nerve head ONH, Retinal nerve fiber layer RNFL, and macula GCC has a role in early diagnosis and monitoring progression of glaucoma.

Key words: High definition optical coherence tomography (HD-OCT), Optic nerve head (ONH), Retinal nerve fiber layer (RNFL), Ganglion cell complex (GCC)

INTRODUCTION

Glaucoma is an optic neuropathy characterized by irreversible Ganglion cell death that manifest clinically as characteristic optic nerve head (ONH) and retinal nerve fiber layer (RNFL) changes with correlating visual field defects.[1] The death of axons is associated and may be Ganglion cell death. The characteristic changes of the optic nerve head and visual field defects on perimetry confirms the diagnosis of Glaucoma. The loss of retinal ganglion cells (RGC) is considered as an important step in pathogenesis, in cascade of events leading to retinal nerve loss and changes of optic nerve head.[2] Different modalities have been used for early diagnosis of glaucoma, but search for ideal modality for early diagnosis remains elusive.[3]

Ophthalmoscopy and optic disc photography traditionally have been used as primary method for structural assessment in Glaucoma. Inter observer variability in detecting subtle changes make ophthalmoscopy alone as poor method for detecting glaucoma progression.[4] Photography also has low to medium inter observer agreement.[5\

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Different perimetric methods applied, but they seems to have a limited role. Visual field defects to be evident on White-to-White perimetry, it requires at least 30-40% neuronal cell loss to occur, which is irreversible. Short wave length perimetry (Blue on Yellow perimetry) may diagnose Glaucomatous field defects 3-5 years before traditional perimetry but it could not be popularized. Secondly yellowing of crystalline lens decreases transmission & affects the reliability of SWAP. Frequency-doubling test (FDT) is also introduced but not commonly done. Other high pass perimetry, scotopic perimetry, motion threshold perimetry, pattern discrimination perimetry, and temporal modulation perimetry were postulated but most are not commercially available or commonly used.[6]

Newer ocular Imaging methods such as optical coherence tomography to overcome pit falls and flaws and capable of quantifying structural parameters of optic disc and RNFL with good precision and reproducibility, shown better diagnostic performance. Optical Coherence tomography first described in 1991, is a non contact, non-invasive imaging technique that can reveal layers of Retina by looking at interference patterns of reflected laser light.[7]

Today optical coherence tomography is a widely used and proven imaging modality for evaluation of Glaucoma. The imaging method gives not only

qualitative assessment but also quantitative assessment of these changes, structural changes in optic nerve head (ONH), retinal nerve fiber layer (RNFL) and ganglion cell layer (GCC) in the macular region, are now routinely diagnosed with OCT. The ganglion cell complex (GCC) studied by OCT, which has the maximum density at macula. roughly one Lac ganglion cells are in human retina and half of this number is centered on the fovea. Macular scan with GCC analysis could be early indicator of this disease.[7]

Spectral domain OCT (SD-OCT) is a recent technique that enables the imaging of Ocular structures with higher resolution and faster scan rate compared with previous version of this technology, TD-OCT. Optic nerve head parameters have also been found to have excellent ability to discriminate between normal eyes and eyes with even mild Glaucoma. The parameters found to have the greatest diagnostic capability and vertical rim cup to disc ratio. These ONH parameters were found to be as good as RNFL thickness parameters in diagnosing Glaucoma.[8]

SUBJECTS AND METHODS

This is cross-sectional, observational study was conducted at Ch. Rehmat Ali Hospital Lahore from March 2014 to September 2015. All procedures conformed to the guide lines of Declaration of Helsinki. All the patients underwent comprehensive Ophthalmic examination, that includes; visual acuity, refractive error, best corrected visual acuity (BCVA), intra ocular pressure (IOP) with Goldman applanation Tonometer, anterior segment examination by slitlamp biomicroscopy, including pupillary reaction, optic nerve head (ONH) evaluation and fundus exam with 90D Lens, anterior chamber angle with Gonioscope for grading of angle, corneal patchymetry for CCT and visual field analysis. Patients who have best corrected Visual acuity at least 6/9, normal anterior segment on slit lamp examination, open angle on gonioscopy, and ONH with Glaucomatous changes (i.e. increased C:D ratio and neuro-retinal rim narrowing were included. Those patients who have BCVA less than <6/9, refractive error outside the interval (-6D--+8) or >3D cylinder, media opacity, previous ocular surgery, anterior or posterior segment active infection of either eye, evidence of Diabetic retinopathy or macular oedema and H/O vertiprofen injection and concomitant use of hydroxy chloroquin or chloroquin were excluded. Single well trained examiner did OCT after pupillary dilatation. Optic nerve scans were acquired with 4mm concentric maps. The GCC maps were based on macular protocol centered on Fovea with a cube of 512* 128 with automated measurement of GCC and internal limiting membrane. OCT scan with signal strength more than 6 were included in analysis. ONH parameters on cirrus HD-OCT like C:D ratio para papillary RNFL thickness and GCC were calculated for each case.

RESULTS

The study includes 115 patients, 65 were males (56%), while 50 were females (44%). They were divided in two groups (A) diagnosed Glaucoma patients (B) Pre perimetric Glaucoma (Glaucoma suspect) The second group further divided in to (1) patients with ocular hypertension i.e. raised IOP, normal C:D ratio & Visual fields. (2) enlarged physiological cup, increased C:D ratio ,Normal IOP and visual fields. Age of patients ranges from 23 years to 54 years with a mean of 47.3(SD±10.3). On OCT analysis patients with diagnosed Glaucoma RNLF was significantly thinner in superior and inferior quadrents, neuro retinal rim was smaller in these patients.CD area ratio and vertical CD dimameter ratio were larger in these glaucoma patients. In present study glaucomatous eyes, RNFL defects were found in superior hemisphere in 22 eyes (33.66%) and in inferior hemispherein 38 eyes (63.33%). Similarly glaucomatous eyes 48(80%) showed abnormal findings in GCC analysis on sector deviation map as well as in thickness map. The other group patients with ocular hypertension 14 eyes (56%) showed RNFL defects varying from yellow to red colour (border line to marked thinning) with variable distribution in superior, inferior hemisphere. Similarly 6 eyes (20%) showed deviation in GCC thickness map. Patients with enlarged Cup(increased C:D ratio),normal IOP, and visual fields comprises younger age group, eight eyes (26.66%) showed changes in RNFL thickness map and 4 eyes (13.33%) showed GCC analysis changes.

DISCUSSION

Glaucoma is the clinical manifestation of irreversible damage to retinal ganglion cells resulting in RNFL loss.[9] This becomes functional evident as visual field loss, detected on perimetry. It is now established fact that structural damage detected by RNFL defects precedes functional loss of 40% axons to occur before any detectable change occur in visual function.[10] Although automated perimetry considered as Gold standard for Glaucoma diagnosis , do not show changes until significant neuronal loss occurs.[2] Early manifest glaucoma trial (EMGT) evaluated the effects of immediate treatment versus no treatment on early stage, Open angle glaucoma, and showed that early treatment is important for lowering patients risk of glaucoma progression,[11] the problem is a large no of patients remains in the group (glaucoma

suspect) for a long period, when to initiate the treatment or undue treatment for glaucoma, both strategies, have merit and demerits. In the present study, cirrus HD-OCT maps are studies for three parameters to detect Glaucomatous loss, RNFL retinal nerve fiber layer, optic nerve head and ganglion cell complex.

Optic nerve head scanning with cirrus HD-OCT, measures all features of ONH disc anatomy, disc diameter neuro-retinal rim and cup/disc ratio. In our study glaucoma suspect group, patients with ocular hypertension, the C:D ratio is not increased while other groups, diagnosed glaucoma and with enlarged physiological cup, shows significant enlarged cup and increased C:D ratio , thinning of neuroretinal rim. These findings are consistent with results of Medeirs et al.[12]

Retinal nerve fiber layer cirrus HD-OCT profile analysis is displayed on, RNFL thickness map with colour coding, RNFL Graphic representation in double hump, RNFL Quadrants thickness map with red, green, yellow colour coding. In our study RNFL thickness defects are more in inferior quadrant (63.33%) superior quadrant (36.66%) while in glaucoma suspect group (pre-perimetric glaucoma) 56% and 26.66% showed RNFL thickness defects in ocular hypertension increased CD ratio groups respectively. In early to moderate glaucoma, progressive thinning of RNFLthickness measured by SD-OCT i.e. very useful tool to judge progression.

Ganglion cells are large and complex cells extending from inner retina all the way to Lateral geniculate nucleus LGN in mid brain. Ganglion cells begins at inner plexiform layer (IPL) where they synapse with bipolar and amacrine cells. The cell bodies form Ganglion cell layer (GCL) their axons emerge as Retinal nerve fiber layer (RNF). All three segments of Ganglion cells (IPL, GCL & NFL) are known as ganglion cell complex (GCC) animal models, damage to ganglion cell, earliest changes at dendrites, subsequently cell bodies dies.GCC can be used as a supplementary tool in picking up cases of pre-perimetric glaucoma, as GCC loss is significant in pre-perimetric glaucoma.[13] In glaucoma GCC is first to be affected, so evaluation of GCC is early indicator of damage.

In present study Glaucomatous eyes shoes deviation in both GCC sectorial map as well as thickness map changes, while in pre–perimetric glaucoma the significant no of patients shows GCC changes in ocular hypertension 20% and in increased CD ratio group 15% shows GCC changes.

CONCLUSION

High definition optical coherence tomography of ONH optic nerve head, retinal nerve fiber layer RNFL and macula (GCC) has greatly enhanced early diagnosis of open angle glaucoma and progression of glaucoma.

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