Comparison of Retinal Nerve Fiber Layer Thickness obtained by HRT and Functional Parameters by Standard Automated Perimeter in Diagnosis of Glaucoma

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ABSTRACT

Objective: To assess the difference and correlation of selected structural and functional methods in the diagnosis of glaucoma by the evaluation of Retinal nerve fiber layer thickness and visual field defects.

Methods: 60 patients including 37 males and 23 females referred at glaucoma clinic (PIPO) Mayo Hospital, Lahore were included in the study. They all underwent tests for visual acuity, slit lamp examination, refraction, fundus examination including Cup Disc ratio, Gonioscopy for status of angle, HRT and VF. The significance between the two groups was assessed by means of 'T'-Test and correlation analysis.

Results: 5 out of the 60 patients had RNFL thickness defect, but they had normal VF, IOP and symmetrical CD ratio. 7 patients with no VF defects with IOP in range of 18-25, CDR 0.4-0.7, had RNFL defects (they were labeled as glaucoma patients and given treatment). 3 patients diagnosed with glaucoma had normal RNFL thickness. HRT found significant parameters CA, CD ratio, Rim-disc ratio, RV ($p<0.05$). The loss of NFL was significantly different ($p<0.01$) among glaucomatous and healthy patients. Another correlation was found by comparison of RNFL thickness loss to MD ($p=0.03$).

Conclusion: By comparison of HRT and automated perimetry among the glaucomatous patients it is concluded that the combination of structural and functional methods can positively improve diagnosis of early glaucoma and better recognize the progression of glaucomatous neuropathy of the optic nerve.

Key words: Glaucoma, intraocular pressure, HRT, Automated perimetry, Visual Field defects.

INTRODUCTION

Glaucoma is one of the leading causes of blindness. A disease of the optic nerve, it is most often a slowly progressive loss of sight that is not detected by the patient until it has reached advanced stages. It has been defined as an optic neuropathy with characteristic structural damage to optic nerve, associated with progressive retinal ganglion cell death, loss of nerve fibers and visual field loss. The loss of vision begins in the peripheral visual field and only affects the central clear vision in its advanced stages. There have been revolutionary changes in the understanding, diagnosis, and management of glaucoma. The importance of intraocular pressure above 21.0 mmHg as a singular factor has been significantly minimized since about one-third of patients might show classical glaucomatous damage with normal intraocular pressure or in spite of controlled IOP after glaucoma surgery, there may be progressive loss of fields.

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An appropriate management of glaucoma includes the diagnosis of early changes both at the structural and functional levels. Glaucoma is characterized by loss of retinal ganglion cells and their axons. This damage is irreversible, so the best way of dealing with glaucoma is early diagnosis for an immediate and appropriate treatment.

Graefe described the optic nerve damage in glaucoma (1855). The appearance of the optic nerve head (ONH) has been used to assess the presence and the progression of the disease. However, the interpretation of the ONH is subjective and there is wide variation between observers and even between examinations by the same observer in the evaluation of optic disc characteristics. Attempts have been made on the production of objective tools devised to enable an early and sure diagnosis of the disease, and to point out its possible progression.

One of the oldest and simplest technologies is the stereoscopic ONH photography, extremely useful, permitting an objective permanent recording of the ONH aspect and giving the possibility to observe changes with time. Unfortunately, even experts of value are not able to agree from the photographs on discriminating between normal and glaucomatous disc. This has led ophthalmologists to search for more sensitive testing to try and find glaucoma earlier. Early detection and treatment would thus spare more of the optic nerve.

The objective of static threshold automated perimetry in glaucoma is the efficient detection of visual field defects and the accurate measurement of progressive field loss. Automated perimetry is a psychophysical test of visual function necessarily dependent upon the subjective response of the patient. The test involves the detection of a stimulus the luminance of which is greater than that of the background of a given constant luminance. Threshold static perimetry expresses the minimum detectable stimulus brightness at individual locations within the visual field in terms of sensitivity units (decibels) and provides a contour of the height and shape of the hill of vision. The numerical information, which is an estimate of the true threshold, is usually compared with that from a database of normal individuals of the same age.

As suggested by many studies, about 30 to 50% of the nearly 1.2 million nerve fibers are lost before standard visual field tests can detect the loss. Greater sensitivity for detecting glaucoma was demonstrated when retinal nerve fiber layer imaging was added to subjective assessment of the disc. A decreased thickness of the retinal nerve fibers (RNF) may be observed as an earliest sign of glaucoma, certainly before the abnormalities of the optic disc and/or the visual field, pushed the investigators to find technologies sophisticated enough to measure this significant sign.

Multimodal assessment with a device that analyzes both disc topography and nerve fiber layer may be advantageous for detecting early glaucoma. The Heidelberg Retinal Tomograph is a confocal laser scanning system designed for acquisition and analysis of three dimensional images of the posterior segment. It enables the quantitative assessment of the topography of ocular structures and the precise follow-up of topographic changes

These modalities are especially useful to quantitatively assess retinal nerve fibre layer (RNFL) thickness in addition to changes in the disc in suspected cases of glaucoma. It is established that retinal nerve fibre layer in glaucoma may show thinning even before the field changes are detected. HRT imaging system has the highest diagnostic precision, accuracy, reproducibility and is able to diagnose glaucoma before confirmed visual field change.

There is lack of agreement as to whether functional or structural tests are the most sensitive for detecting early glaucomatous damage. Recent randomized clinical trials indicate that the first detectable glaucomatous change at early stages of the disease can be either functional or structural. Thus, some have suggested that a combination of functional and structural tests will increase diagnostic sensitivity

The purpose of our study was to find a correlation between the results of HRT and VFA in the diagnosis, management and follow-up of glaucoma patients.

MATERIAL & METHODS

60 patients including 37 males and 23 females referred at glaucoma clinic (PIPO) Mayo Hospital, Lahore were included in the study. They all underwent tests for visual acuity, slit lamp examination, refraction, fundus examination including Cup Disc ratio, Gonioscopy for status of angle, HRT and VF. The significance between the two groups was assessed by means of T-Test and correlation analysis. All those patients with primary open angle glaucoma.between 40 and 60 years of age were included in the study. All those patients with primary angle closure glaucoma, secondary glaucoma, like inflammatory and neovascular glaucoma etc and with Lens Induced Glaucoma were excluded from the study.

RESULTS

	PSD(db)			CD Ratio		IOP(mmHg)	
Range	0.5-2.5	2.5=6	>6	0.3-0.5	>0.5	11-18	>18
No. of pts	7(12%)	34(57%)	19(32%)	28(47%)	32(53%)	16(27%)	44(73%)

	RNFL Thickness (mm)			Mean deviation (db)		
Range	<0.2	0.2-0.32	>0.32	-0.5- -4	-4 - -8	>-8
No. of pts	16((27%)	32(53%)	12(20%)	7(12%)	34(57%)	37(62%)

in our study, of all the 60 patients undergoing the Visual Field Assessment and Heidelberg retinal tomography, 7 patients (12%) had PSD in the range of 0.5 – 2.5 db showing Mean Deviation in the range of –o.5 -4 db. 34 patients (57%) had PSD 2.6-6 db, MD -4 to -8, and 19 patients (32%) had >6 db, MD > -8. 28 patients (47%) had CD ratio between 0.3-0.5 while the rest 32 patients (53%) had CD ratio >0.5. On applanation tonometry 27% of patients (16 patients) had IOP in the range of 11-18 mmHg. The rest 73% patients (44 patients) had IOP greater than 18 mmHg. The Assessment of Retinal Nerve Fiber Thickness showed the following results. 16 Patients (27%) had RNFL Thickness < 0.2mm. 32 patients (53%) had RNFL thickness in range of 0.2-0.32 mm, and the rest 12 patients (20%) had it above 0.32mm.

- Seven out of the 60 patients had RNFL thickness defect, but they had normal VF, IOP and symmetrical CD ratio.
- 9 patients with no VF defects with IOP in range of 18-25, CDR 0.4-0.7, had RNFL defect (they were labeled as glaucoma patients and given treatment)
- Four patients diagnosed with glaucoma had normal RNFL thickness.
- HRT found out significant parameters to be CA, CD ratio, Rim-disc ratio, RV ($p<0.05$).
- The loss of NFL was significantly different ($p<0.01$) among glaucomatous and healthy patients.
- Another correlation was found by comparison of RNFL thickness loss to MS ($p<0.0$-) and MD ($p=0.03$).

DISCUSSION

Glaucoma is the second leading cause of blindness worldwide. It is a disease of the elderly people with mean age 60 years. It is a serious irreversible optic neuropathy that is usually overlooked as during the diagnosis. Patients are usually asymptomatic during the early phase of the disease as the disease is gradual in onset, with peripheral vision loss instead of a central one, and frequently asymmetrical involvement. Optic disc changes precede visual field defects by many years. There may be nerve fibre loss up to 40% before conventional perimetry is able to demonstrate visual field defects.

There have been huge advancements in the medical field regarding diagnosis and assessment of glaucoma. A correct diagnosis is the key to proper management of patients. In many cases the patients still experience loss of vision in spite of anti-glaucoma treatment. The need of time is the proper assessment of patients and then their management regarding

In the past decade a variety of imaging and specialized parametric and electro-physiologic devices for glaucoma diagnosis have been introduced. This trend indicates dynamism in the subspecialty of glaucoma and an interest in developing new and better ways to quantify glaucomatous damage and detect glaucoma at early stage. However, it also creates difficulties, both in the clinical research setting and in clinical practice, regarding how to incorporate these new technologies.

Advanced diagnostic imaging instruments can distinguish between glaucomatous and non-glaucomatous eyes with good sensitivity and specificity, but recent studies have shown that the instruments detect different pools of patients with glaucoma. In other words a nerve fiber layer analyzer may detect a pool of glaucomatous patients different from a scanning laser device that maps disc topography, suggesting that multimodal assessment with a device that analyzes both disc topography and nerve fiber layer may be advantageous for detecting early glaucoma.

Both functional (SAP, SWAP, FDT) and structural (HRT, OCT, GDx) tests have been shown to predict which patients will progress, whether in ocular hypertension or glaucoma. Most of the published studies used older versions of currently available instruments, and these studies must be updated. The thoughtful application of these tests to individuals with significant risk of impairment is beginning to become useful in clinical practice. However, no formula or program has been developed to determine which patients to treat. These devices do not supplant, but rather add to clinical assessment of the optic nerve.

The Ocular Hypertension Treatment Study found that an abnormal score on the Moorfields Regression Analysis (MRA) on a confocal scanning ophthalmoscope (Heidelberg Retina Tomograph, HRT, Heidelberg Engineering) imparted a more than three times increased risk of developing a glaucomatous field defect. The MRA was the most predictive parameter measured by the HRT. Similar smaller studies have examined the ability of an earlier version of optical coherence tomography (OCTII, Carl Zeiss Meditec) to predict visual field defects in patients with suspicious optic nerves and the ability of scanning laser polarimetry (GDx VCC, Carl Zeiss Meditec) to predict the progression in glaucoma patients.

In another study, Shah and colleagues used a variety of testing modalities i.e. OCT, HRT, GDx,

Short wavelength automated perimetry (SWAP) and FDT, to examine participants in the Diagnostic Innovations in Glaucoma Study. Both glaucoma patients and normal subjects, as defined by photo assessment and SAP visual field testing, were included. The investigators found that functional assessment (FDT and SWAP) improved the sensitivity of diagnostic testing when added to imaging. However, reduced specificity was demonstrated with SWAP.

K. H Lee and colleagues found that a close comparison between optic nerve head parameters and visual field defects is required for the evaluation and follow-up of glaucoma patients. They also found that a close comparison between the superior and inferior rim area and inferior or superior field defect, respectively, may provide additional clues in the evaluation and HRT results[21].

In our study, 7 out of 60 patients undergoing both Perimetry and HRT, had RNFL Thickness defects , although they had normal VF, IOP and symmetrical CD ratio. They were labeled as glaucoma suspects and were kept on follow up. Another 9 patients with no VF defects, and having IOP in the range of 18-25, CDR 0.4-0.7, had RNFL thickness defects and they were labeled as glaucoma patients and treatment started. 4 patients diagnosed with glaucoma had normal RNFL thickness. The study, in addition to the diagnosis of glaucoma patients, also showed that the loss of RNFL was significantly different ($p<0.01$) among glaucomatous and healthy patients.

We also found statistically significant correlation between the superior quadrant rim area and the corresponding inferior sector of total and pattern deviation plots, and between the inferior quadrant rim area and the corresponding superior sector of visual field. This confirmed the regional relationship between optic nerve head parameters and visual field defects.

CONCLUSION

- By comparison of HRT and automated perimetry among the glaucomatous patients it is concluded that the combination of structural and functional methods can positively improve diagnosis of early glaucoma and better recognize the progression of glaucomatous neuropathy of the optic nerve.
- Evaluation and follow up of glaucoma patients, a close comparison between optic nerve head and visual fields is a must requirement.

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