Original Article

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Comparison of Optical Coherence Tomography and Humphrey Visual Field in Early Glaucoma Diagnosis: Observational Study

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Abstract

Objective: To study the diagnostic accuracy of Retinal nerve fibre layer (RNFL) thickness and perimetric field defects in early diagnosis of Primary open angle glaucoma(POAG). *Materials and Methods:* Eyes fulfilling inclusion criteria were selected for this study from ophthalmology glaucoma clinic outpatient department at R.L. Jalappa Hospital. Informed consent was take from all patients. They were divided into 3 groups. Group I consists of 23 glaucoma suspect eyes.Group II consists of 23 eyes with early glaucoma. Group III consists of 23 normal eyes. Each patient underwent best corrected visual acuity (BCVA), Intraocular pressure (IOP) estimation, slit lamp examination, fundus examination particularly for Cup Disc ratio (C/D), gonioscopy, Optical Coherence Tomography (spectral) and Humphrey Visual Field (HVF) - 750. Superior, inferior, nasal, temporal, average RFNL thickness compared among all groups. Mean deviation (MD) and pattern standard deviation (PSD) of Humphrey visual field analysis statistically comparedwith RFNL thickness. Statistical analysis was made by ANOVA test. *Results:* The mean intra ocular pressure was 18.9mmHg, 21.56mmHg, 12.0mmHg in group I, II, III respectively. The mean C/D ratio was 0.90, 0.98, 0.4 in these three consecutive groups. Average RNFL thickness was 94.2microns, 72.33 microns, 112.23microns in three consecutive groups. The mean of mean deviation (MD) and the mean of pattern standard deviation (PSD) in group I showed -0.73 and 1.70 respectively. The mean MD and the mean PSD in group II showed -3.58 and 9.20 respectively. The mean MD and the mean PSD in group III showed -0.215 and 1.272 respectively. *Conclusion:* OCT is superior in diagnosis of glaucoma particularly in suspect groups. RNFL thickness measured by OCT discriminates better between glaucomatous, glaucoma suspect and normal eyes.

Keywords: OCP; HFA.

Introduction

Glaucoma is a progressive optic neuropathy characterized by retinal ganglion cell loss and associated morphological changes of optic nerve and nerve fibre layer [1]. It is the main cause of irreversible legal blindness. Structural damage is accompanied by visual function changes. In the initial stages glaucoma induces structural alteration such as apoptosis of ganglion cells, nerve fibre loss, optic disc alteration which is asymptomatic and cannot be diagnosed clinically until functional changes are detected such as early scotomas in visual field. Therefore, early diagnosis of glaucoma before visual field alterations helps in accurate treatment with goal to maintain and preserve visual functions and minimum damage.

Optical Coherence Tomography (OCT) is a modern imaging technology using low coherence tomography to provide high resolution cross-sectional images to retinal nerve fibre and optic nerve head [2,3]. It is most sensitive method for detection of early glaucomatous nerve damage that precede optic disc and visual field damage [4,5].

Objective of the Study

To study the diagnostic accuracy of optic disc nerve fibre layer thickness and perimetric visual field defects in early diagnosis of POAG.

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Materials and Methods

Group I consist of 23 glaucomatous suspect eyes. Group II consists of early glaucoma eyes and Group III consists of 23 normal eyes.

This is an observational study.

Inclusion Criteria

Subjects of 18 years of age or older.

Exclusion Criteria

1. Subjects with history of intraocular surgery
2. History of ocular trauma
3. History of diabetes mellitus
4. History of hypertension
5. Pathological disorder affecting visual field
6. Pathological changes in posterior segment
7. Colour blindness
8. Refractive media opacity.

Each of the patients of the 3 groups underwent standard ophthalmic examination like best corrected visual acuity (BCVA), intraocular pressure (IOP) estimation, slit lamp examination, fundus examination particularly for Cup Disc ratio (C/D), Optical Coherence Tomography (stratus) and Humphrey Visual Fields (HVF) - 750.

For suspect group (Group I).

1. BCVA 6/12 and more.
2. IOP> 21 mg on at least 2 occasions or
3. C/D ≥ 0.6 or C/D asymmetry0.2 between2 eyes.
4. Normal perimetry .
5. Open angle by gonioscopy

For early glaucoma group (Group II).

1. BCVA 6/12 or more.
2. IOP ≥ 21 mmHg on at least 2 occasions, multiple IOP fluctuations per day ≥ 8mmHg
3. C/D > 0.6 and asymmetry 0.2 between eyes.
4. Patients irrespective of antiglaucoma medications.
5. Open angle by Gonioscopy.
6. Abnormal perimetry as defined by Anderson criteria.

Anderson Criteria

Abnormal perimetry is defined as sensitivity of 3 non-edge points <5% of general population. 1 among 3 scotomasshowing probability of <1%. Glaucoma hemifield test is abnormal. HFA-750 done under Swedish Interactive Threshold Algorithm (SITA) standard strategy, central 30-2. Near vision was corrected with the glasses. Target size III was used. PSD and MD were noted in all patients compared with each group and results were analysed. Visual field used for analysis satisfied the following criteria: fixation losses <25% and false positive and false negative response <20%. For each reliable field, mean deviation (MD) and PSD were recorded. All subjects underwent Spectral domain OCT. To obtain OCT images with the best quality, all subjects pupil was dilated with 1% tropicamide. The fast RNFL thickness 3.4 detecting program was used. Superior (46-135 degrees), inferior (226-315 degrees), temporal (316-345 degrees) and nasal (136-225 degrees) RNFL thickness were compared between the three groups. 23 eyes of 18 patients,23 eyes of 15 patients & 23 eyes of 11 patients are divided into group I, II, III respectively.

In group I age ranges from 44 to 72 eyes

In group II age ranges from 40years to 68 years.

In group IIIage ranges from 42 years to 70 years.

Table 1: Age Distribution

Age	Group I	Group II	Group III
40-50 years	5	6	8
51-60 years	7	1	8
61-70 years	9	15	7
>70 years	2	1	1

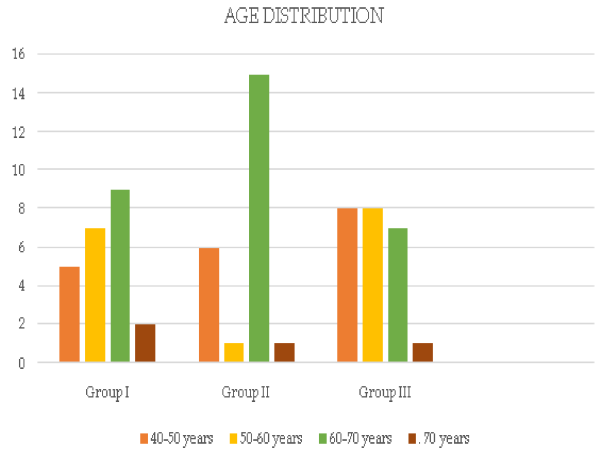
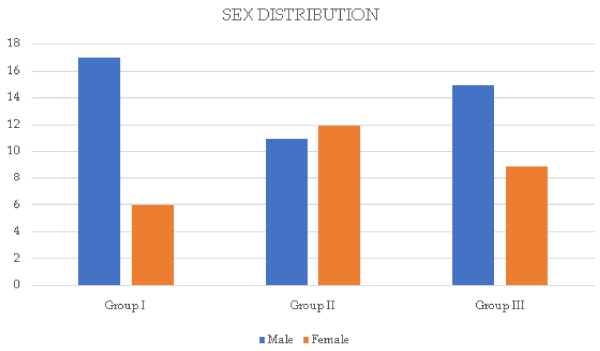


Table 2: Sex Distribution

	Group I	Group II	Group III
Male	17	11	15
Female	6	12	9



Males are more in group 1 followed by group III and group II

Statistical analysis was done by ANOVA test.

Fisher value correlation coefficient to find the relationship between variables. p value <0.05 was considered statistically significant and p value> 0.05 was considered statistically not significant.

Table 3:

Variables in each groups.		No.	Mean	Std. Deviation	Minimum	Maximum
Age in years	1	23	58.70	9.484	42	72
	2	23	59.09	9.742	40	68
	3	24	57.25	9.692	42	70
	Total	70	58.33	9.534	40	72
C/D (Cup/Disc)	1	23	.9087	1.26918	.40	6.70
	2	23	.9843	1.00025	.30	.80
	3	24	.4000	.08847	.20	.50
	Total	70	.7591	1.04107	.20	6.70
Average RNFL in microns	1	23	94.204348	16.4756978	49.7000	120.2000
	2	23	72.334783	24.3891669	44.6000	168.8000
	3	24	112.233333	7.8973120	98.8000	130.3000
	Total	70	93.200000	23.8423141	44.6000	168.8000
Inferior RNFL in microns	1	23	110.565	17.5287	61.0	132.0
	2	23	84.591	21.1872	6.6	114.0
	3	24	128.750	8.3938	108.0	148.0
	Total	70	108.266	24.4769	6.6	148.0
Superior RNFL in microns	1	23	111.57	16.973	68	138
	2	23	86.43	12.064	66	112
	3	24	129.42	8.490	112	148
	Total	70	109.43	21.886	66	148
Nasal RNFL in microns	1	23	77.00	13.181	41	98
	2	23	56.43	11.889	32	82
	3	24	93.00	9.367	78	110
	Total	70	75.73	18.923	32	110
Temporal RNFL in microns	1	23	70.74	13.632	32	88
	2	23	49.96	12.758	20	74
	3	24	86.96	8.518	74	106
	Total	70	69.47	19.214	20	106
Mean deviation (MD)	1	23	-.732609	1.0477735	-2.8000	1.0600
	2	23	-3.586957	.5101732	-4.8000	-2.8000
	3	24	.215000	.2225543	-.1200	1.1000
	Total	70	-1.345571	1.7596769	-4.8000	1.1000
Pattern standard deviation (PSD)	1	23	1.702609	.7056410	.8000	2.9000
	2	23	9.208696	13.7480218	3.4000	57.0000
	3	24	1.272500	.1475672	1.0100	1.6000
	Total	70	4.021429	8.5918224	.8000	57.0000
Intra ocular pressure (IOP) in mmHg	1	23	18.95652	4.587317	12.000	26.000
	2	23	21.56522	3.952285	16.000	30.000
	3	24	12.00000	2.766256	8.000	18.000
	Total	70	17.42857	5.565347	8.000	30.000

Table 4:

ANOVA

		Sum of Squares	df	Mean Square	Fisher value	Significance
Average RNFL In microns	Between Groups	18730.845	2	9365.422	30.620	.000
	Within Groups	20492.615	67	305.860		
	Total	39223.460	69			
Inferior RNFL in microns	Between Groups	23083.147	2	11541.574	42.358	.000
	Within Groups	18255.870	67	272.476		
	Total	41339.018	69			
Superior RNFL In microns	Between Groups	21854.005	2	10927.003	65.384	.000
	Within Groups	11197.138	67	167.121		
	Total	33051.143	69			
Nasal RNFL In microns	Between Groups	15758.191	2	7879.095	58.985	.000
	Within Groups	8949.652	67	133.577		
	Total	24707.843	69			
Temporal RNFL In microns	Between Groups	16135.093	2	8067.547	57.882	.000
	Within Groups	9338.350	67	139.378		
	Total	25473.443	69			
Means deviation(MD)	Between Groups	182.638	2	91.319	197.256	.000
	Within Groups	31.018	67	.463		
	Total	213.656	69			
Pattern standard deviation(PSD)	Between Groups	923.906	2	461.953	7.423	.001
	Within Groups	4169.634	67	62.233		
	Total	5093.539	69			
Intra ocular pressure(IOP)	Between Groups	1154.534	2	577.267	39.361	.000
	Within Groups	982.609	67	14.666		
	Total	2137.143	69			

Table 5:

Dependent Variable	Individual (I) group	Other group(J)	Mean Difference (I-J)	Std. Error	p value
C/D	1	2	-.07565	.30143	.969
		3	.50870	.29827	.241
	2	1	.07565	.30143	.969
		3	.58435	.29827	.155
	3	1	-.50870	.29827	.241
		2	-.58435	.29827	.155
Average(RNFL)	1	2	21.8695652*	5.1571809	.000
		3	-18.0289855*	5.1031776	.003
	2	1	-21.8695652*	5.1571809	.000
		3	-39.8985507*	5.1031776	.000
	3	1	18.0289855*	5.1031776	.003
		2	39.8985507*	5.1031776	.000
Inferior RNFL in microns	1	2	25.9739*	4.8676	.000
		3	-18.1848*	4.8166	.002
	2	1	-25.9739*	4.8676	.000
		3	-44.1587*	4.8166	.000
	3	1	18.1848*	4.8166	.002
		2	44.1587*	4.8166	.000
Superior RNFL in microns	1	2	25.130*	3.812	.000
		3	-17.851*	3.772	.000
	2	1	-25.130*	3.812	.000
		3	-42.982*	3.772	.000
	3	1	17.851*	3.772	.000
		2	42.982*	3.772	.000

Dependent Variable	Individual (I) group	Other group(J)	Mean Difference (I-J)	Std. Error	p value
Nasal RNFL In microns	1	2	20.565*	3.408	.000
		3	-16.000*	3.372	.000
	2	1	-20.565*	3.408	.000
		3	-36.565*	3.372	.000
	3	1	16.000*	3.372	.000
		2	36.565*	3.372	.000
Temporal RNFL In microns	1	2	20.783*	3.481	.000
		3	-16.219*	3.445	.000
	2	1	-20.783*	3.481	.000
		3	-37.002*	3.445	.000
	3	1	16.219*	3.445	.000
		2	37.002*	3.445	.000
Mean deviation(MD)	1	2	2.8543478*	.2006399	.000
		3	-.9476087*	.1985389	.000
	2	1	-2.8543478*	.2006399	.000
		3	-3.8019565*	.1985389	.000
	3	1	.9476087*	.1985389	.000
		2	3.8019565*	.1985389	.000
Pattern standard deviation(PSD)	1	2	-7.5060870*	2.3262834	.008
		3	.4301087	2.3019237	.983
	2	1	7.5060870*	2.3262834	.008
		3	7.9361957*	2.3019237	.004
	3	1	-.4301087	2.3019237	.983
		2	-7.9361957*	2.3019237	.004
Intra ocular pressure(IOP)	1	2	-2.608696	1.129286	.077
		3	6.956522*	1.117461	.000
	2	1	2.608696	1.129286	.077
		3	9.565217*	1.117461	.000
	3	1	-6.956522*	1.117461	.000
		2	-9.565217*	1.117461	.000

In glaucoma suspect (group I) which includes disc suspect and ocular hypertension, the mean Cup Disc ratio is 0.9, average RNFL thickness 94.2µ. The minimum average RNFL thickness varies from minimum 49.7µ to maximum 120.2µ. The mean inferior RNFL thickness is 110.56µ. The mean superior RNFL thickness is 111.57µ. The mean nasal RNFL thickness 77.00µ and mean temporal RNFL thickness is 70.74µ which follows double hump pattern in OCT. 8 eyes had IOP equal to or higher than 21 mmHg on atleasttwo different occasions without optic disc abnormalities. Cup disc ratio was not statistically significant between the three groups. 4.35% i.e, one eye had glaucomatous changes in HFA and 13.04% (3 eyes) of 23 eyes had OCT changes in suspect group. The glaucomatous HFA showed focal defects in nasal aspect.Oneeye withOCT abnormalityhad HFA changes. 2 eyes showed OCT abnormality for glaucoma but not related to field defect. The mean MD was - 0.73 and the mean PSD was 1.702. The mean IOP in group I was 18.95.

In glaucoma group II the mean RNFL thickness measured by OCT was outside normal limits in all patients. The mean C/D was 0.75. The mean average RNFL thickness of group II was 72.33µ. The mean inferior, mean superior, mean nasal and mean temporal RNFL thickness was 84.5µ, 86.4 µ, 56.4µ and 49.9µ respectively. This group also follows double hump pattern in OCT. The mean MD and mean PSD in group II was - 3.5 and 9.2086 respectively.The mean IOP in group II was 21.56 mmHg.

In normal group III the mean C/D was 0.4, average RNFL thickness was 112.34µ. The mean inferior RNFL, mean superior RNFL, mean nasal RNFL and mean temporal RNFL thickness was 128.75µ, 129.42µ, 93µ and 86.96µ. The mean IOP in this group was 12mm Hg. The mean MD and mean PSD was 0.215 and 1.272 respectively.There were no OCT and HFA changes.

Statistical analysis was done by ANOVA to know the significance between these groups.

In group I, average RNFL thickness showed statistically significant difference between group II and group III with p value being 0.00 and 0.003. In group I Superior, inferior, nasal, temporal RNFL thickness showed statistically significant with group II p value being 0.000.

In group II, average, inferior, superior, nasal and temporal RNFL thickness showed statistically significant difference between group I with p value 0.000.

In group III, the average thickness of RNFL showed statistically significant difference between group I and II with the p value 0.003 and 0.000 respectively. In group III inferior RNFL thickness showed statistically significant difference with group I p value being 0.002. In group III Superior, inferior, nasal, temporal RNFL thickness showed statistically significant difference with group I and II with p value of 0.000.

The mean deviation showed statistically significant difference between all the groups. The Pattern standard deviation (PSD) in group I did not show statistical significance with group II and group III with p value 0.008 and 0.953.

Discussion

Glaucoma leads to irreversible blindness but early diagnosis and treatment are essential for controlling the disease and reducing the vision loss. OCT is considered as an objective investigation not that provides quantitative information about RNFL thickness, In addition there are no effects of refractive error and corneal birefringence on OCT information.

In our study, there was significant difference in RNFL thickness among suspect group, early glaucoma and suspect group.

RNFL thickness measured by OCT is a good tool for differentiating glaucoma from normal eyes. P Sihotaand R Sony [6] found the average RNFL thickness followed by inferior RNFL thickness had the highest power to discriminate glaucomatous and normal eyes. Chen H Y and Huang M L [7] showed that the inferior RNFL was the best parameter for differentiation. In our study 50% followed ISNT rule in group I, 60% in group II and 61% in group III. In ISNT rule, inferior RNFL fibres are thick followed by superior, nasal and temporal.

Our study showed statistically significant correlation between MD, PSD and average RNFL thickness (1.060, 2.900 and p value 0.000). In our study inferior RNFL thickness was the best parameter for differentiation.

The limitation of our study was sample size is less.

Results

The mean intra ocular pressure was 18.9 mmHg, 21.56 mmHg, 12.0mmHg in group I, II, III respectively. The mean C/D ratio was 0.90, 0.78, 0.4 in these three consecutive groups. Average RNFL thickness was 94.2microns, 72.33 microns, 112.23microns in three consecutive groups. The mean of mean deviation (MD) and the mean of pattern standard deviation (PSD) in group 1 showed -0.73 and 1.70 respectively. The mean MD and the mean PSD in group II showed -3.58 and 9.20 respectively. The mean MD and the mean PSD in group III showed -0.215 and 1.272 respectively.

Conclusion

OCT is superior in diagnosis of glaucoma particularly in suspect groups. RNFL thickness measured by OCT discriminates better between glaucomatous, glaucoma suspect and normal eyes

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