Original Research Article

OCT based evaluation of retinal changes in multiple sclerosis

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ABSTRACT

Background: Optical coherence tomography is a non-invasive imaging technique routinely used in ophthalmology to visualize and quantify the layers of the retina. It also provides information on optic nerve head topography, peripapillary retinal nerve fibre layer thickness and macular volume which correlate with axonal loss. These measurements are of interest in optic neuropathies and in multiple sclerosis. The OCT parameters are now used as endpoints in neurologic clinical trials.
Methods: A prospective study involving 30 patients of multiple sclerosis and equal number of age and sex matched controls were subjected to evaluation of retinal changes (peripapillary retinal nerve fiber layer and central macular thickness) using Zeiss Cirrus HD-OCT machine. The results collected were then subjected to statistical analysis.
Results: Significant RNFL thinning was seen in patients of multiple sclerosis compared to the age and sex matched controls. Marked thinning was seen in superior and temporal quadrants of right eye (p value of 0.002 and 0.008 respectively) and all quadrants in left eye with a p value of < 0.001. Patients with multiple sclerosis for more than 5 yrs showed statistically significant RNFL thinning in the superior quadrant of right eye (p<.005), however, no such changes were seen in rest of the quadrants of right eye and in none of the quadrants of left eye Significant RNFL thinning was seen in the patients of multiple sclerosis without prior history of optic neuritis than patients with prior history of optic neuritis which was statistically significant with p value of .001.
Conclusions: Patients with multiple sclerosis for more than 5 yrs showed statistically significant RNFL thinning in the superior quadrant of right eye (p<.005). Significant RNFL thinning was seen in the patients of multiple sclerosis without prior history of optic neuritis than patients with prior history of Optic neuritis which was statistically significant with p value of .001. No significant changes were seen in central macular thickness in multiple sclerosis compared to the controls which was corroborated by statistical analysis (p value of 0.37).

Keywords: Central macular thickness (CMT), Multiple sclerosis, Optical coherence tomography, Retinal nerve fiber layer (RNFL) thickness

INTRODUCTION

Optical coherence tomography (OCT) is a non-invasive imaging technique routinely used in ophthalmology to visualize and quantify the layers of the retina. It can provide diagnostic information and quantitative data on biological tissues at high resolution of 10 microns. The principle of OCT is analogous to ultrasound; however, the system uses light instead of acoustic waves. Standard circular OCT scans (3.4-mm diameter) around the ONH provide objective and reproducible measurements of the retinal nerve fibre layer (RNFL) thickness, with a 6.9%

coefficient of variation between repeated scans in normal eyes.[1] It also provides information on optic nerve head topography, peripapillary retinal nerve fibre layer thickness, and macular volume which correlate with axonal loss. These measurements are of interest in optic neuropathies and in multiple sclerosis, and OCT parameters are now used as endpoints in neurologic clinical trials. Originally developed for retinal diseases and glaucoma, optical coherence tomography (OCT) allows direct visualization and measurement of the optic nerve head topography, and of retinal nerve fiber layer (RNFL) thickness with micron-scale resolution.[2] Quantification of the RNFL thickness by OCT provides an indirect measure of axonal and neuronal loss in the anterior visual pathways. The RNFL thickness is of interest in optic neuropathies and in numerous neurologic disorders such as multiple sclerosis (MS).[3] As OCT is non-invasive, easy to obtain and highly reproducible, therefore it can be used as a marker of axonal loss and as an endpoint in clinical trials. It is particularly useful in MS, in which the anterior visual pathways are commonly affected. In vivo analyses of retinal layers in multiple sclerosis and previous reports have been published stating retinal thinning in multiple sclerosis, however more reports on the same and from our country are lacking. Hence, this study was done to analyze the RNFL thickness and macular morphology in patients of multiple sclerosis.

Aim and objectives

To determine the role of OCT in evaluating retinal changes in multiple sclerosis.

METHODS

A prospective study involving 30 patients of multiple sclerosis and equal number of age and sex matched controls were subjected to evaluation of retinal changes (peripapillary retinal nerve fiber layer and central macular thickness) using Zeiss Cirrus HD-OCT machine. Measurement of central macular thickness (CMT) and retinal nerve fiber layer (RNFL) thickness was done in patients of multiple sclerosis and age and sex matched normal population. The MS patients were further subdivided into groups based on their presentation that are with / without optic neuritis, also on the duration of disease. The CMT and RNFL thickness were compared between these two groups as well.

Statistical analysis

The data collected was entered and analyzed in SPSS (statistical package for social sciences) version 20:0.

RESULTS

The CMT and RNFL thickness was measured in MS patients and the age and sex matched normal subjects. The MS patients were further divided into 2 groups based

on their presentation that is with or without optic neuritis and p-value < 0.05 was considered as significant.

Table 1: Distribution of multiple sclerosis patients based on presentation.

Presentation	Number of patients
With optic neuritis	21 (70%)
Without optic neuritis	09 (30%)
Total	30

Table 2: Distribution of multiple sclerosis patients based on duration of disease.

Duration of disease	No of patient
< 5 years	19 (66.6%)
> 5 years	11 (33.3%)
Total	30

Table 3: Central macular thickness in eyes of multiple sclerosis patients and normal subjects.

Range of CMT	Normal subjects	Multiple sclerosis
200-208	22 (36.6%)	29 (48.3%)
209-217	06 (10%)	18 (30%)
218-226	19 (33.3%)	04 (6.6%)
226-234	08 (13.3%)	04 (6.6%)
235-243	04 (6.6%)	04 (6.6%)
244-253	01 (1.6%)	01 (1.6%)
Total no. of eyes	60	60
Mean	213 µ	207 µ
Median	220.5µ	210.5µ

2 tailed p value equals 0.25.

Table 4: CMT based on presentation with or without optic neuritis.

CMT	With optic neuritis	Without optic neuritis	P value
CMT right eye	209	245	.009
CMT left eye	192	221	.006

CMT: 21 (70%) out of 30 patients of multiple sclerosis presented with history of optic neuritis and remaining 09 (30%) out of 30 patients had no prior history of optic neuritis. On comparing the mean CMT between the two groups showed no statistically significant difference in both the eyes (p value <0.009). No significant changes were seen in central macular thickness in multiple sclerosis compared to the controls and no meaningful change was seen based on the duration of disease which was corroborated by statistical analysis (p value of 0.37).

RNFL thickness: In this study, significant RNFL changes in multiple sclerosis patients were seen compared with the age and sex matched controls. Significant changes were seen in superior and temporal quadrant of the right

eye in (p<0.005) but no notable change was seen in the nasal and inferior quadrant. On comparing RNFL changes in the left eye significant changes were found in all quadrants (p<0.005). This is amply evident in line diagrams 4 (a-c).

Table 5: Comparison of RNFL thickness between multiple sclerosis patients and normal subjects in both eyes (Quadrant wise).

	Mean in normal subjects	Mean in multiple sclerosis patients	P value
Right eye			
Superior	125.4	105.2	0.002
Inferior	122.2	117.1	0.368
Nasal	70.7	70.3	0.892
Temporal	65.2	58.4	0.008
Left eye			
Superior	127.01	88.4	<0.001
Inferior	124.71	72.2	<0.001
Nasal	73.08	60.01	<0.001
Temporal	66.23	46.23	<0.001

Table 4: RNFL thickness (both eyes) of multiple sclerosis patients based on presentation with or without optic neuritis.

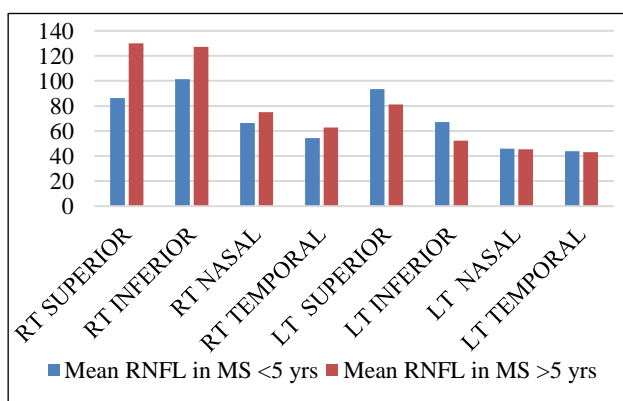| RNFL	Mean RNFL in pts with optic neuritis	Mean RNFL without O.N.	p value
Right eye (quadrant wise)			
RT superior	122	65	<.001
RT inferior	130	86	<.001
RT nasal	74	61	.003
RT temporal	60	52	0.112
Left eye (quadrant wise)			
LT superior	68	81	0.03
LT inferior	58	66	0.01
LT nasal	43	51	0.19
LT temporal	41	36	0.01

Figure 1: Mean RNFL in multiple sclerosis based on duration of disease.

In case of patients of multiple sclerosis RNFL thinning was seen in right eye of patients with disease of duration less than 5 years compared to those who had it for more than 5 years. This was statistically strongly significant with a p value of < 0.005. The bar diagram emphasizes this point amply.

This study clearly shows significant RNFL thinning in patients of multiple sclerosis compared with the controls and this is statistically strongly significant with a p value of < 0.001.

Comparison between two groups of patients of MS based on the duration of disease less than or more than 5 years showed significant difference in right superior quadrant (p<0.001), but no significant difference in other quadrants (p>0.05) also no significant difference was found in the left eye.

This study compared Multiple Sclerosis patients presenting with and without optic neuritis revealed significant difference in RNFL in between the two groups

in right superior, inferior and nasal quadrants (p<0.05), and all quadrants in the left eye (p<0.005).

DISCUSSION

Mean age of multiple sclerosis patient was 34.36 years. The maximum number of patients were between 41-50 years of age 11/30 (36.6%) and if the next group is also included it would amount to 21/30 (70%). This indicates that the usual age of patients of multiple sclerosis who attend an eye OPD range from 41 to 60 years and beyond. This is in consonance with the global prevalence as given in the study of Rosati G.[4] The same is true with the control group [12/30 (40%) and 23/30 (71.6%)]. This indicates that the study group and the control group have been well age matched in this study. The maximum numbers of patients were having disease duration of less than 5years (19/30-63.3%).

On comparing the central mean thickness between patients with history of optic neuritis and those without the history of optic neuritis it was clearly evident that there was no significant difference between the two groups (p value <0.009). It was also found that there was no significant difference based on the duration with p value < 0.37. These findings are also similar to the findings obtained in a previous study by Trip et al.[5,6]

The findings of this study which showed significant RNFL changes in Multiple Sclerosis patients compared to the age and sex matched controls is in accordance with a similar study done by Pulicken et al. Similar findings were reported in the study by Henderson et al wherein thinning of the RNFL was seen only in the temporal quadrant of patients with primary progressive MS,whereas the group with secondary progressive MS had significant RNFL thinning in overall mean, superior and temporal quadrants.[8]

This study showed that there was significant difference in the RNFL thickness in patients of MS compared to the controls. Also, in patients with disease duration of more than 5 yrs significant difference was seen in the superior quadrant of the right eye. However, no significant difference was seen in the left eye of MS patients with more than 5 yrs duration. Similar results were found in a previous study by Ratchford et al.[9]

However, no significant difference was found in CMT in between the two groups in either eyes. Almost similar findings were noted in previous studies. Parisi et al, using an early generation of TDOCT technology, demonstrated thickness of the RNFL was reduced by an average of 46% in the affected eyes of the patients with MS versus the eyes of controls (*P* <0.01), and by an average of 28% when affected eyes were compared with the 'unaffected' eyes of the same patient (*P* <0.01).[5] They also demonstrated reduced temporal and overall RNFL thickness in eyes with and without optic neuritis when compared with controls.

Fisher et al, using the Stratus TDOCT, similarly detected a reduction in RNFL thickness in subjects with multiple sclerosis, in addition to demonstrating an RNFL thickness difference between eyes with and without optic neuritis.[10] Costello et al, using the Stratus TDOCT device, demonstrated difference in RNFL thickness between eyes with and without optic neuritis.[11]

Finally, Trip et al, showed a difference in RNFL thickness between optic neuritis-affected eyes and controls as well as between optic neuritis-affected eyes and optic neuritis unaffected eyes, however, no difference was detected between optic neuritis-unaffected eyes and controls.[5] In this study, there is no difference with respect to age and sex and the study population is age and sex matched with normal subjects giving credence to the study.

CONCLUSION

Significant RNFL thinning was seen in patients of multiple sclerosis compared to the age and sex matched controls in superior and temporal quadrants of right eye with a p value of 0.002 and in all quadrants in the left eye with a p value of 0.001. Significant RNFL thinning was seen in the patients of multiple sclerosis without prior history of optic neuritis than patients with prior history of optic neuritis which was statistically significant with p value of 0.001. Even though no significant changes were seen in central macular thickness in multiple sclerosis compared to the controls, yet this study shows that OCT can be an effective tool in mapping of retinal changes in MS patients.

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