Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijss/2017/422

Original Article

Optical Coherence Tomography Based Evaluation of Retinal Changes in Parkinson's Disease

Sonal Singh[1], Rishi Sharma[2], V S Gurunadh[3], Sandeep Shankar[4]

[1]Department of Ophthalmology, Command Hospital (Eastern Command), Kolkata, West Bengal, India, [2]Department of Ophthalmology, Military Hospital Shimla, Shimla, Himachal Pradesh, India, [3]Professor and HOD, Department of Ophthalmology, Military Hospital Wellington, Nilgiris, Tamil Nadu, India, [4]Associate Professor, Department of Ophthalmology, Armed Forces Medical College, Pune, Maharashtra, India

Abstract

Introduction: Optical coherence tomography (OCT) is a non-invasive imaging technique routinely used to visualize and quantify the layers of the retina. 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 fibre layer (RNFL) thickness with micron-scale resolution. It can provide diagnostic information and quantitative data on biological tissues at high resolution of 10 μ. Parkinson's disease (PD), the second most common neurodegenerative disease, is progressive disorder with selective dopaminergic neuronal loss, mainly in the substantia nigra.

Materials and Methods: A total of 30 patients of PD and equal number of age and sex matched controls were subjected to evaluation of retinal changes (peripapillary retinal nerve fiber layer [RNFL] and central macular thickness [CMT]) using Zeiss Cirrus HD-OCT machine.

Results: Significant RNFL thinning was seen in patients of PD compared to age and sex matched controls. Marked thinning was seen in superior and temporal quadrants of the right eye ($P = 0.002$ and $P = 0.008$, respectively) and in all quadrants of the left eye with a $P < 0.001$. Patients with disease duration multiple sclerosis (MS) for more than 5 years showed significant RNFL thinning in the superior quadrant of the right eye ($P < 0.005$), however, no such changes were seen in rest of the quadrants of the right eye and left eye. Significant RNFL thinning was seen in the patients of MS without prior history of optic neuritis ($P = 0.001$).

Conclusion: Significant RNFL thinning was seen in patients of PD compared to the age and sex matched controls. The duration of PD also influenced the RNFL thickness as statistical strongly significant thinning ($P < 0.001$) was seen in both eyes of patients with disease of more than 5 years duration. However, no significant changes were seen in CMT in PD compared to the controls.

Key words: Central macular thickness, Optical coherence tomography, Parkinson's disease, Retinal nerve fiber layer thickness

INTRODUCTION

Optical coherence tomography (OCT) is a non-invasive imaging technique routinely used 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 μ. As OCT is noninvasive, easy to obtain and highly reproducible, therefore it can be used as a marker of axonal loss and as an endpoint in clinical trials.[1]

Access this article online

www.ijss-sn.com

Month of Submission : 06-2017
Month of Peer Review : 07-2017
Month of Acceptance : 08-2017
Month of Publishing : 08-2017

Parkinson's disease (PD), is the second most common neurodegenerative disease, is a progressive disorder with selective dopaminergic neuronal loss mainly in the substantia nigra.

It was first described by James Parkinson in 1817.[2] Visual symptoms are common in PD, and include reduced spatial contrast sensitivity, motion perception abnormalities, color deficiency, and visual hallucinations. Thinning of the retinal nerve fiber layer (RNFL), the inner retinal layer, and macular thickness have been documented in several small studies, and it has been proposed that this may correlate with loss of these dopaminergic cells and progression of functional visual abnormalities in PD patients.[3-6] *In vivo* analyses of retinal layers in Parkinson's have been done and the previous reports have been published stating retinal thinning however, more reports on the same and

Corresponding Author: Dr. Rishi Sharma, Department of Ophthalmology, Military Hospital Shimla, Jutogh Cantt, Shimla - 171 008, Himachal Pradesh, India. Phone: +91-9882829560. E-mail: rs19april81@gmail.com

from our country are lacking. The successful use of OCT in clinical trials indicates that OCT may provide a valid and reliable biomarker to tracing neurodegeneration within the retina and a primary outcome measure to detect the effects of new therapeutic strategies and follow-up of disease progression of PD and multiple sclerosis. Furthermore, this biomarker may be useful in identifying the disease early in the course so that early treatment can be started. This would be particularly valuable in settings where sophisticated neuroimaging is not available. However, retinal nerve fiber thinning has been found in PD in relatively small numbers of patients, and how the structural damage of the retina changes with disease process is not well understood. Further studies in larger series are needed to ensure reproducibility and to evaluate the possibility to define cutoffs that could serve clinical purposes. Hence, this study was conducted to study RNFL thickness and macular morphology in PD.

Aim and Objectives

To determine the role of OCT in evaluating retinal changes in PD.

MATERIALS AND METHODS

A prospective study involving 30 patients of PD and equal number of age and sex matched controls were subjected to evaluation of retinal changes (peripapillary retinal nerve fiber layer [RNFL] and central macular thickness [CMT]) using Zeiss Cirrus HD-OCT machine. Measurement of CMT and RNFL thickness was done in patients of PD and age and sex matched normal population. The PD patients were further subdivided into groups based on the duration of disease. The CMT and RNFL thickness were compared between these two groups as well.

RESULTS AND ANALYSIS

The data collected was entered and analyzed in Statistical Package for the Social Sciences version 20:0. The CMT and RNFL thickness were measured in patients of PD and the age and sex matched normal subjects.

Age Distribution

a. PD: Mean age of patient was 55.6 years. The maximum number of patients were between 51 and 60 years of age 18/30 (60%) and if the next group is also included it would amount to 26/30 (86.6%). This indicates that the usual age of patients of PD who attend an eye outpatient department range from 51 to 60 years and beyond. This is in consonance with the global prevalence.[7]
b. The same is true with the control group (20/30 [66.6%] and 28/30 [93.3%]). This indicates that the study group and the control group have been well age matched in this study.
c. PD: The maximum numbers of patients were having disease duration of more than 5 years (18/30-60%).

CMT

a. PD**:** No significant change in CMT was found in PD patients when compared with the controls in both the eyes (two-tailed $P = 0.37$). This has been depicted in Table 1. Similar results were obtained in a previous study by Aaker *et al*.[8] However, a previous study by Altintas *et al*.[4] showed significant reduction in macular volume and thickness by OCT.

RNFL Thinning

a. Significant RNFL thinning was noted in PD patients when compared with age and sex matched controls. Table 4a emphasizes this point amply. This is statistically strongly significant with $P = 0.001$. The mean RNFL thickness in superior, inferior, and nasal quadrants of the right eye was 112.67 μ, 98.37 μ, and

Table 1: CMT in eyes of PD patients and control

Range of CMT	Normal subjects	PD
200-208 (%)	08 (13.3)	04 (6.6)
209-217 (%)	05 (8.3)	07 (11.6)
218-226 (%)	03 (5)	03 (5)
226-234 (%)	14 (23.3)	16 (26.6)
235-243 (%)	24 (40)	26 (43.3)
244-252 (%)	06 (10)	04 (6.6)
Total number of eyes	60	60
Mean	211 μ	225.5 μ
Median	210.5 μ	220.5 μ

CMT: Central macular thickness, two-tailed *P*=0.37, PD: Parkinson's disease

Table 2: Comparison of RNFL thickness (quadrant wise of the right eye) in PD patients and normal subjects

Quadrant	Mean in normal subjects	Mean in PD	*P* value
Superior	125.20	112.67	0.001
Inferior	122.2	98.37	0.001
Nasal	70.07	64.63	0.026
Temporal	65.1	67.53	0.105

RNFL: Retinal nerve fiber layer, PD: Parkinson's disease

Table 3: Comparison of RNFL thickness (quadrant wise of the left eye) in PD patients and normal subjects

Quadrant	Normal subjects	PD	*P* value
Superior	108.34	126.23	<0.001
Inferior	101.02	124.12	<0.001
Nasal	69.34	72.43	<0.069
Temporal	57.14	66.15	<0.001

RNFL: Retinal nerve fiber layer, PD: Parkinson's disease

Table 4a: Distribution of PD patients based on duration of disease

Disease duration	Number of patients (%)
<5 years	12 (40)
>5 years	18 (60)
Total	30

PD: Parkinson's disease

Table 4b: RNFL in Parkinson's disease patients based on duration of disease - in right eye (quadrant wise)

RNFL changes in the right eye (quadrant wise)			
Quadrant	**Mean RNFL (>5 years duration of disease)**	**Mean RNFL (<5 years duration of disease)**	***P* value**
Superior	86.12	130.5	<0.001
Inferior	96.34	103.4	<0.001
Nasal	63.13	67.2	<0.001
Temporal	66.5	67.24	<0.001

RNFL: Retinal nerve fiber layer

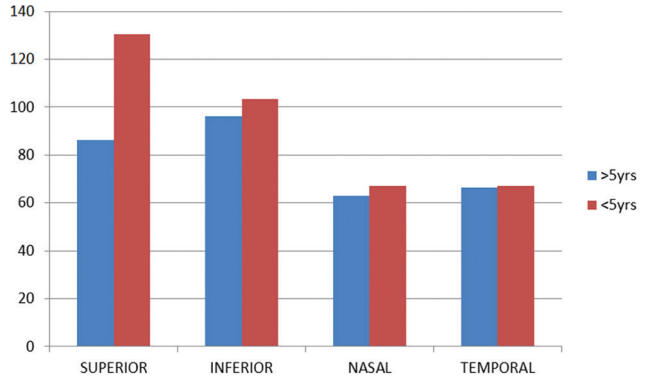

Diagram 4b: Retinal nerve fiber layer changes in the right eye (quadrant wise)

Table 4c: Retinal nerve fiber layer changes in Parkinson's disease patients based on duration of disease - Left eye (quadrant wise)

Quadrant	Mean RNFL (>5 years duration of disease)	Mean RNFL (<5 years duration of disease)	*P* value
Superior	81.45	120.5	<0.001
Inferior	92.23	105.5	<0.001
Nasal	62.12	69.4	<0.001
Temporal	65.31	68.2	<0.001

RNFL: Retinal nerve fiber layer

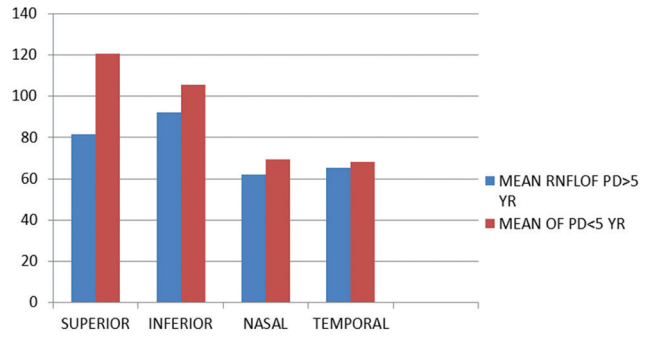

Diagram 4c: Retinal nerve fiber layer changes in the left eye (quadrant wise)

64.63, respectively, compared to the controls (125.20, 122.2, and 70.07 microns, respectively). However, on comparing the RNFL thickness in the temporal quadrant of the right eye did not reveal any significant difference between PD patients when compared with age and sex matched controls ($P = 0.105$). Comparison of RNFL thickness in the superior quadrant, inferior, and temporal quadrants of the left eye revealed that mean RNFL of PD patient was 126.23, 124.12, and 66.15 μ and on comparing with the controls (108.34, 101.02, and 57.14 μ, respectively) statistically strongly significant difference was seen ($P < 0.001$). This is amply evident from (Tables 2 and 3). No significant difference was found between the two in the nasal quadrant. ($P = 0.069$). These findings are also similar to the findings obtained in few studies in the past which showed decreased RNFL thickness in PD patients when compared with the controls[4-6]. No significant change in macular thickness was seen on 30 patients of PD when compared with 30 age and sex matched control. Similar results were obtained in a previous study by Grant D Aaker *et al.* however, a previous study by Altintas *et al.*[4] showed a significant reduction in macular volume and thickness by OCT.

This study also shows that RNFL change also depends on the duration of PD. RNFL thinning in cases of PD was observed in those with disease of more than 5 years duration compared to those with duration <5 years. This was statistically strongly significant with a $P < 0.001$. Table 4b and c emphasizes this point amply however, this cannot be corroborated by previous research work due to paucity of the same. 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 PD compared to the age and sex matched controls. Marked thinning was seen in superior, inferior, and nasal quadrants of the right eye and superior, inferior, and temporal quadrants of the left eye and is this is statistically strongly significant with a $P < 0.001$. The duration of PD also influenced the RNFL thickness as statistically strongly significant thinning ($P < 0.001$) was seen in both eyes of patients with disease of more than 5 years duration. In this study, no significant changes were seen in CMT in

PD compared to the controls which were corroborated by statistical analysis $P = 0.32$. Even though no significant changes were seen in CMT in PD compared to the controls, yet this study shows that OCT can be an effective tool in mapping of retinal changes in PD patients.

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How to cite this article: Singh S, Sharma R, Gurunadh VS, Shankar S. Optical Coherence Tomography Based Evaluation of Retinal Changes in Parkinson's Disease. Int J Sci Stud 2017;5(5):200-203.

Source of Support: Nil, **Conflict of Interest:** None declared.