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Original Research Article

Role of Optical Coherence Tomography in Parkinson's Patients: A Comparative Study in a Tertiary Care Centre

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Abstract:

Introduction: Parkinson's disease is characterized by loss of dopaminergic neurons in the substantia nigra. Dopamine which is found in amacrine and interplexiform retinal cells is the major mediator neurotransmitter of retina. In the follow-up of Parkinson's disease, the thinning of the retinal nerve fibre layer may be a critical marker to monitor progression of the disease.

Aim: This study aimed to evaluate and compare the retinal nerve fibre layer (RNFL) thickness and macular thickness in Parkinson's disease (PD) patients and control group and to correlate with disease severity and duration of illness.

Materials and Methods: A total number of 40 PD patients and 40 controls were recruited during the study period of 9 months. Patients up to stage 3 PD were recruited based on Fulfilment of the UKPDS Brain Bank Criteria. RNFL thickness and macular thickness and volume were measured using OCT. UPDRS scores were calculated in PD patients.

Results: There was a statistically significant reduction in RNFL thickness in average (adjusted mean 94.34 vs 99.99, $p \leq 0.001$), superior (adjusted mean 118.15 vs 124.13, $p \leq 0.001$), inferior (adjusted mean 104.95 vs 126.55, $p \leq 0.001$) and temporal (adjusted mean 67.11 vs 74.36) PD group compared to the control group. The macula thickness also was significantly reduced in inner superior (adjusted mean 313.7 vs 312.41, $p < 0.001$), central (adjusted mean 238.15 vs 251.51, $p < 0.001$), outer superior (adjusted mean 267.61 vs 277.09, $p = 0.014$), outer inferior (adjusted mean 256.80 vs 272.00, $p \leq 0.001$) PD group compared to the control group.

Conclusion: The mean superior, inferior, temporal and average RNFL thickness was significantly lower in the PD group compared to control. The mean macular volume, central, inner superior, outer superior, outer inferior macular thickness was significantly lower in the PD group compared to the control.

Introduction

Globally, the prevalence of Parkinson disease (PD) has doubled in the past 25 years with global estimates in 2019 showing over 8.5 million individuals living with PD. Disability and death due to PD are increasing faster than for any other neurological disorder. [1]

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor symptoms, such as bradykinesia, rigidity, resting tremor, and postural instability and also there is loss of dopaminergic neurons in the substantia nigra [2].

Retina is a peripheral extension of the central nervous system. Of the chemical messengers in the retina, dopamine plays the most evident physiological role in neuro transmission. Dopamine which is found in amacrine and interplexiform retinal cells is the major mediator transmitter of the retina. Reduced dopaminergic stimulation of the ganglion cells is likely to cause abnormal glutamate production and consequently atrophy in nerve fibres. [3,4].

Although it is possible to have an idea about the diagnosis of Parkinson's disease using sophisticated imaging methods, as well as clinical signs, the methods used to monitor the progression of the disease have limitations. In the follow-up of Parkinson's disease, the thinning of the retinal nerve fibre layer (RNFL) may be a critical marker to monitor the progression of the disease.

Methods

The present study is a comparative cross-sectional, hospital-based study done in department of neurology in KAPV Govt medical college Trichy. A total number of 40 PD patients and 40 controls were recruited during the study period of 9 months. Patients up to stage 3 PD were recruited based on Fulfilment of the UKPDS Brain Bank Criteria.

Patients with diabetes, glaucoma, other eye abnormalities and eye related neurological diseases were excluded. Candidates that fulfilled the criteria with normal ocular examinations were undergone SD OCT examinations of both eyes using Heidelberg Engineering spectralis HRA +OCT Rev 1.5.2.0. RNFL thickness and macular thickness and volume were measured. UPDRS scores were calculated in PD patients.

Statistical analysis -Analysis was done using Jamovi software. Quantitative variables like age, RNFL thickness and macular thickness are described using mean and SD. Students T test was used to study the significance of difference in means of these variables. Scatter plot and clustered bar charts with error bars are used to graphically represent the results.

Results

There was a statistically significant reduction in RNFL thickness in average (adjusted mean 94.34 vs 99.99, $p \leq 0.001$), superior (adjusted mean 118.15 vs 124.13, $p \leq 0.001$), inferior (adjusted mean 104.95 vs 126.55, $p \leq 0.001$) and temporal (adjusted mean 67.11 vs 74.36) PD group compared to the control group (fig 1). The macula thickness also was significantly reduced in inner superior (adjusted mean 313.7 vs 312.41, $p < 0.001$), central (adjusted mean 238.15 vs 251.51, $p < 0.001$), outer superior (adjusted mean 267.61 vs 277.09, $p = 0.014$), outer inferior (adjusted mean 256.80 vs 272.00, $p \leq 0.001$) PD group compared to the control group (Fig 2).

The average macular volume is significantly reduced (adjusted mean 6.974 vs 7.141) in PD group compared to control group. While there was not any correlation between UPDRS total and motor scores and superior, inferior, temporal and nasal quadrant RNFL thicknesses, a significant negative correlation was established between UPDRS total (Fig 3) and motor scores (Fig 4) and RNFL mean thickness (P=0.001; P=0.002, respectively).

There was no corelation between UPDRS motor scores and macular thicknesses and average macular volume. There was a significant negative corelation between UPDRS total score and inner temporal macular thickness. (P=0.04) b5ut there was no correlation with regard to average macular volume.

Table 1:

RFNL	group	N	Mean	Std. Deviation	P – value
Superior	Case	80	118.10	4.544	<0.001*
	Control	80	124.13	2.346	
inferior	Case	80	118.76	3.671	<0.001*
	Control	80	124.29	1.911	
temporal	Case	80	67.11	3.353	<0.001*
	Control	80	74.36	1.931	
nasal	Case	80	70.24	4.396	<0.001*
	Control	80	84.65	1.975	
Average	Case	80	94.34	2.728	<0.001*
	Control	80	99.99	10.226	

***Statistically significant with p-value < 0.05**

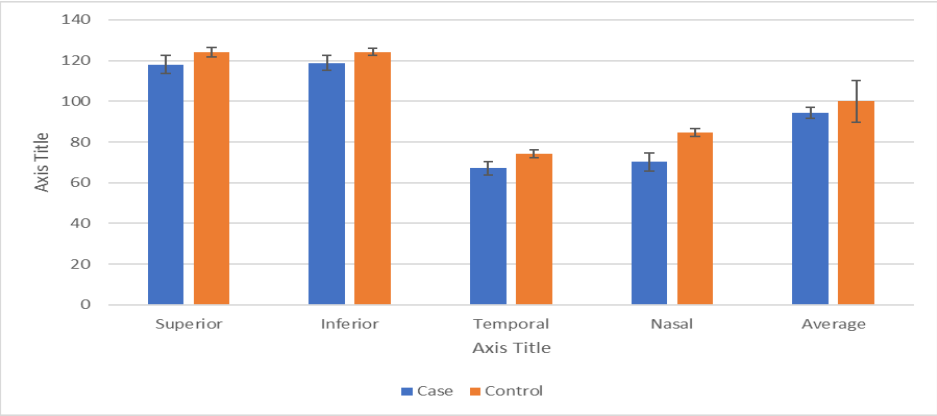

Figure 1:

Table 2:

Macula	Group	N	Mean	Std. Deviation	p-value
Centre	Case	80	238.15	2.194	<0.001*
	Control	80	251.51	1.405	
Inner superior	Case	80	313.70	1.838	<0.001*
	Control	80	312.41	1.726	
Inner inferior	Case	80	312.18	1.784	<0.001*
	Control	80	346.89	2.045	
Inner nasal	Case	80	315.39	2.478	0.972
	Control	80	315.40	2.035	
Inner temporal	Case	80	300.78	1.018	<0.001*
	Control	80	301.74	1.300	
Outer superior	Case	80	267.61	.849	<0.001*
	Control	80	277.09	1.608	
Outer inferior	Case	80	256.80	1.602	<0.001*
	Control	80	272.00	2.403	
Outer nasal	Case	80	290.00	1.180	0.868
	Control	80	290.79	42.195	
Outer temporal	Case	80	257.51	22.276	0.124
	Control	80	261.38	1.602	
volume	Case	80	6.974	.1430	<0.001*
	Control	80	7.141	.0937	

Macular thickness (n=160)

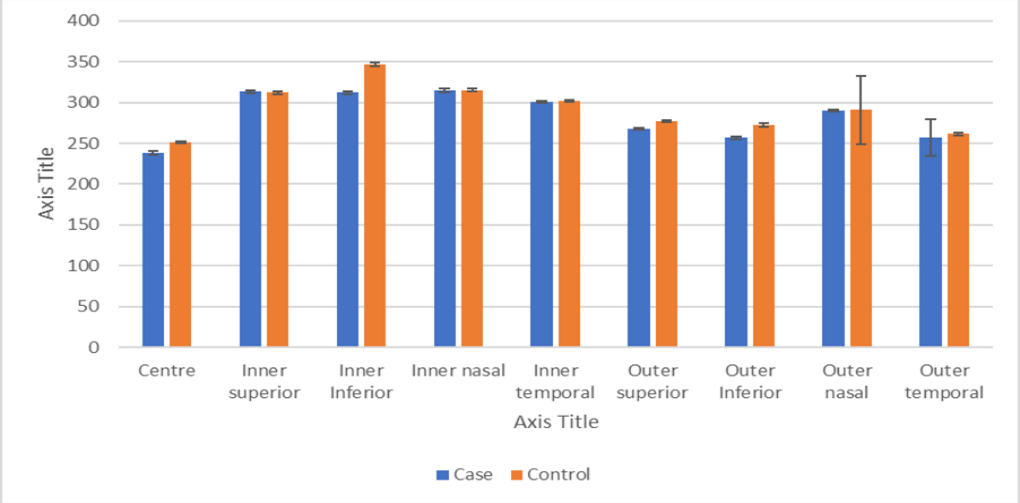

Figure 2:

Table 3: Correlation of UPDRS (T) with RNFL

RNFL	Correlation coefficient	p-value
Superior	**0.146**	**0.369**
Inferior	0.022	0.892
Temporal	0.179	0.270
Nasal	0.086	0.598
Average	-0.331	0.037*

Table 4: Correlation of UPDRS (M) with RNFL

RNFL	Correlation coefficient	p-value
Superior	**0.103**	**0.527**
Inferior	0.078	0.633
Temporal	0.249	0.121
Nasal	-0.030	0.854
Average	-0.547	<0.001*

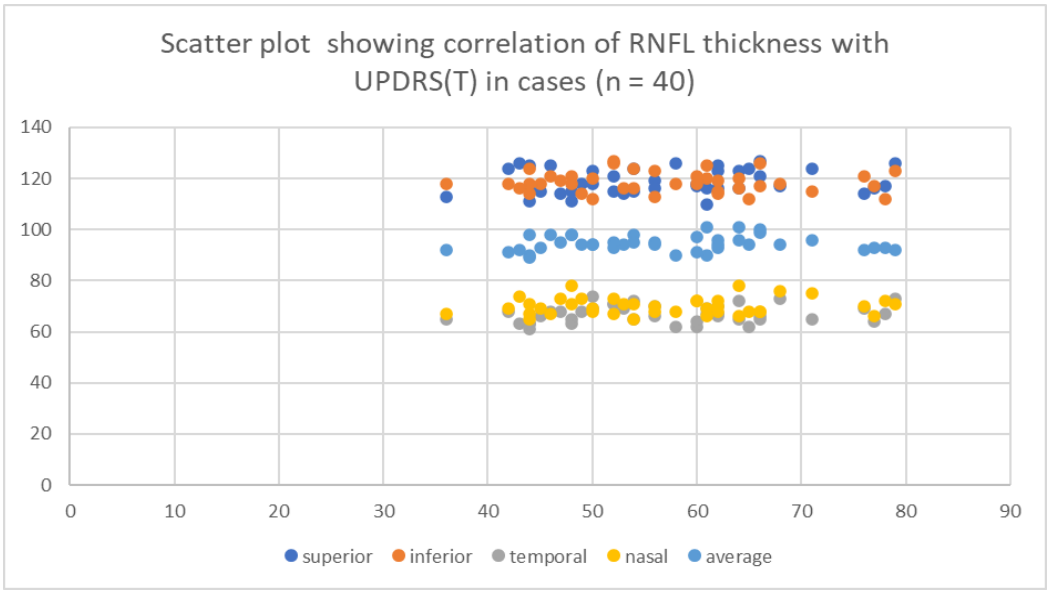

Figure 3:

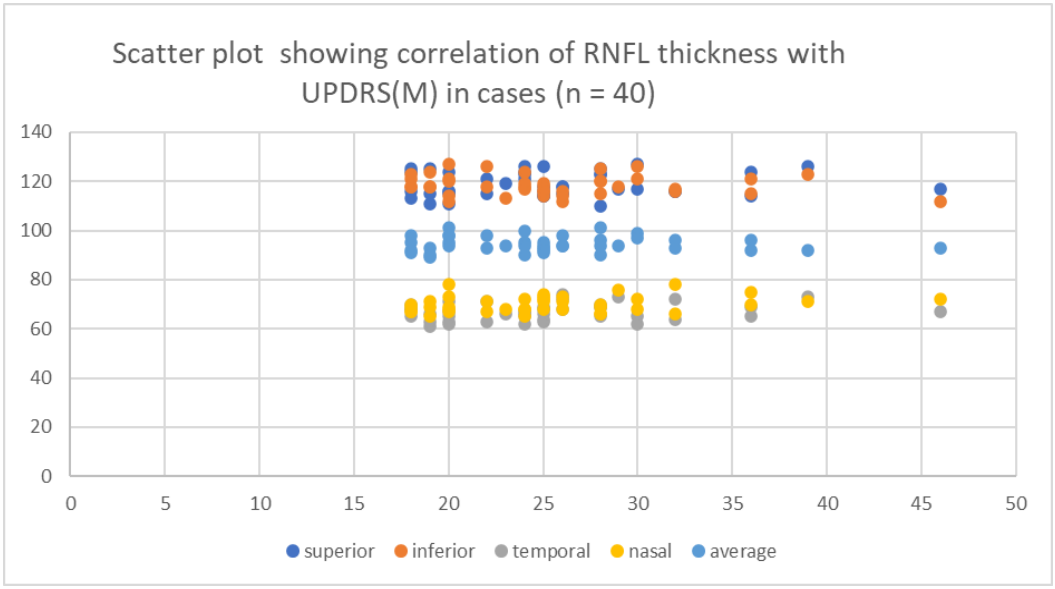

Figure 4:

Discussion

PD is a neurodegenerative disorder caused by a pathologic dopaminergic deficiency in the basal ganglia of the brain. Other regions have also been reported to have either neuronal loss or Lewy pathology (LP) in PD, such as in hypothalamus [5] and the intralaminar nuclei of the thalamus. [6] In late stages of PD, LP is seen throughout cerebral cortex, amygdala and hippocampus. [7,8] DA is one of the most important neurotransmitter in the retina. Pd has been associated with a reduction of retinal dopaminergic cells, mainly of amacrine and interplexiform cells, [9] which sends impulses to both the inner and outer plexiform layers, forming a feedback loop that acts at the level of horizontal cell coupling. The identification of tyrosine hydroxylase-immunoreactive DA neurons in the retina of several patients led to observation of reduced DA innervation in the central retina of parkinsonian patients. [10] However LP was not identified in this area. [11] Thus visual processing might be impaired in PD due to a lack of retinal DA resulting from modification of the receptive field properties of ganglion cells. [12,13] The axons of ganglion cells form the RNFL, and RNFL thickness as well as macular thickness can be measured by OCT.

In this study there was a statistically significant reduction in RNFL measurements in superior, inferior and temporal region in PD groups compared to control group. These results were similar to Inzelberg et al [14] where he found out RNFL thickness in the inferior quadrant was significantly thinner in Parkinson's patients. Kırbaş et al [15] reported significantly thinner mean RNFL and temporal quadrant RNFL in newly diagnosed

Parkinson's patients. But studies did by Aaker GD et. al [16], Tsironi EE et. al [17], Mailankody P et al [18] did not identify any difference between the two groups in RNFL thickness. In our study we also found out that the average macular volume is significantly reduced in PD group compared to control group. It was shown in several studies like Adam CR et. al [19], Altintas O et. al [20], Cubo E et. al [21] that macular thickness or volume was curtailed in Parkinson's disease and that the curtailment resulted from the thinning of inner macular layers, while the outer macular thickness did not have any effect on it.

In our study there was no corelation between UPDRS motor scores and macular thicknesses and average macular volume which was in contrary to Altintas et al [20] where the study demonstrated a correlation of disease severity with inner foveal thickness, but not with macular thickness. In our study there is a significant negative corelation between UPDRS motor score and RNFL thickness which goes in hand with a similar study done by Min Tu et.al [22] where they obtained similar results showing negative correlation between the above parameters.

Our study showed significant negative corelation between UPDRS Total score and mean RNFL thickness with no sign6ificant corelation with regard to each quadrant. Whereas a similar study by El kattan et al [23] showed negative correlation between UPDRS total score and nasal and temporal RNFL thickness. Contrary to our study, many studies have failed to demonstrate a corelation between UPDRS score and RNFL thickness as well as thinning of RNFL in PD patients. This may be attributed to different OCT equipment used by these studies which can affect the RNFL measurements. A gross difference among sample sizes can also account for these disparities.

Conclusion

The mean superior, inferior, temporal, and average RNFL thickness was significantly lower in the PD group compared to the control. The mean macular volume, central, inner superior, outer superior, outer inferior macular thickness was significantly lower in PD group compared to the control. Retinal axonal degeneration happens during the course of PD and is well correlated with the severity of disease as assessed by UPDRS scale and not correlated to duration of illness. These parameters measured by OCT may be useful to evaluate neurodegeneration and assess severity of illness and to monitorise neuroprotective therapies.

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