

Macular Retinal Layer Thickness in Early Parkinson's Disease

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Background

As a direct extension of the central nervous system, the retina frequently mirrors neurodegenerative processes in the brain.¹⁻³

Optical Coherence Tomography (OCT) is a critical noninvasive tool for quantifying retinal microstructure.⁴

While prior OCT studies have established that Parkinson's disease (PD) is associated with thinning in the inner retinal layers and photoreceptor layer, data regarding structural changes in the other layers remain incompletely described.⁵⁻⁷

Characterizing the structural changes across retinal layers could lead to the discovery of reliable, noninvasive biomarkers that enable earlier disease detection and objective monitoring.^{8,9}

Purpose

To compare macular retinal layer thicknesses between patients with Parkinson's disease and cognitively normal controls.

Methods

Study Design: A cross-sectional, case-control study comparing retinal layer thicknesses in adult patients with PD to age- and sex-matched (± 5 years) cognitively normal controls.

Imaging: Retinal imaging of undilated eyes was conducted using spectral-domain OCT (Zeiss Cirrus HD-5000 AngioPlex). High-quality macular cube scans underwent automatic segmentation followed by manual correction to isolate six layers: GC-IPL, INL, OPL, ONL, PRL, and RPE.

Outcomes: Mean thicknesses of each retinal layer and the total retina within the 3-mm and 6-mm rings of the Early Treatment Diabetic Retinopathy Study (ETDRS) grid.

Statistical Analysis: Generalized estimating equations were used to compare layer thicknesses between the cohorts and by Hoehn-Yahr (HY) cluster while accounting for inter-eye correlation. HY clusters were defined as follows: cluster 1 = HY stages 1-1.5; cluster 2 = HY stages 2-2.5; cluster 3 = HY stages 3-4.

Results

Figure 1. Retinal Layer Thicknesses in PD vs. Controls in 6-mm ETDRS Ring.

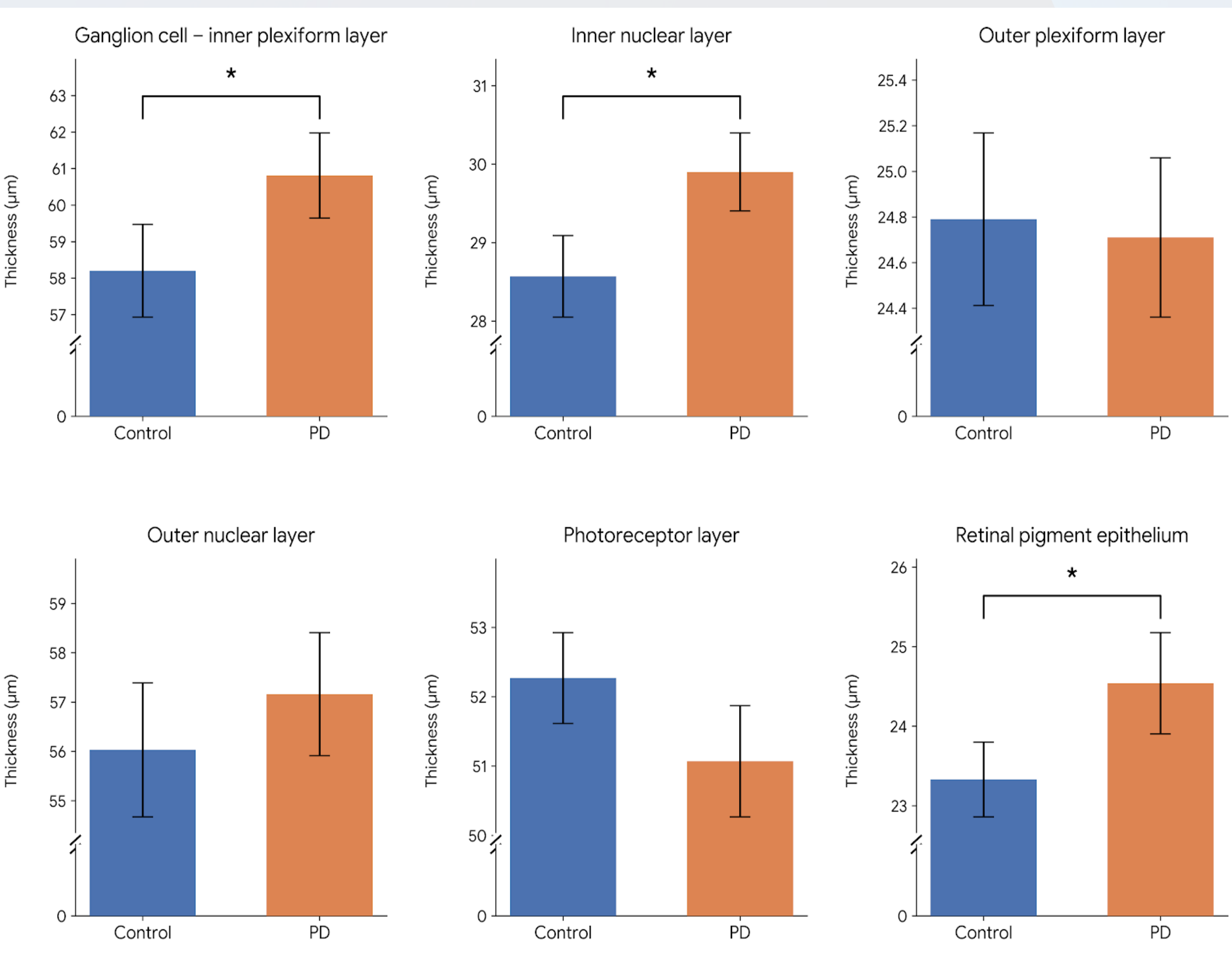
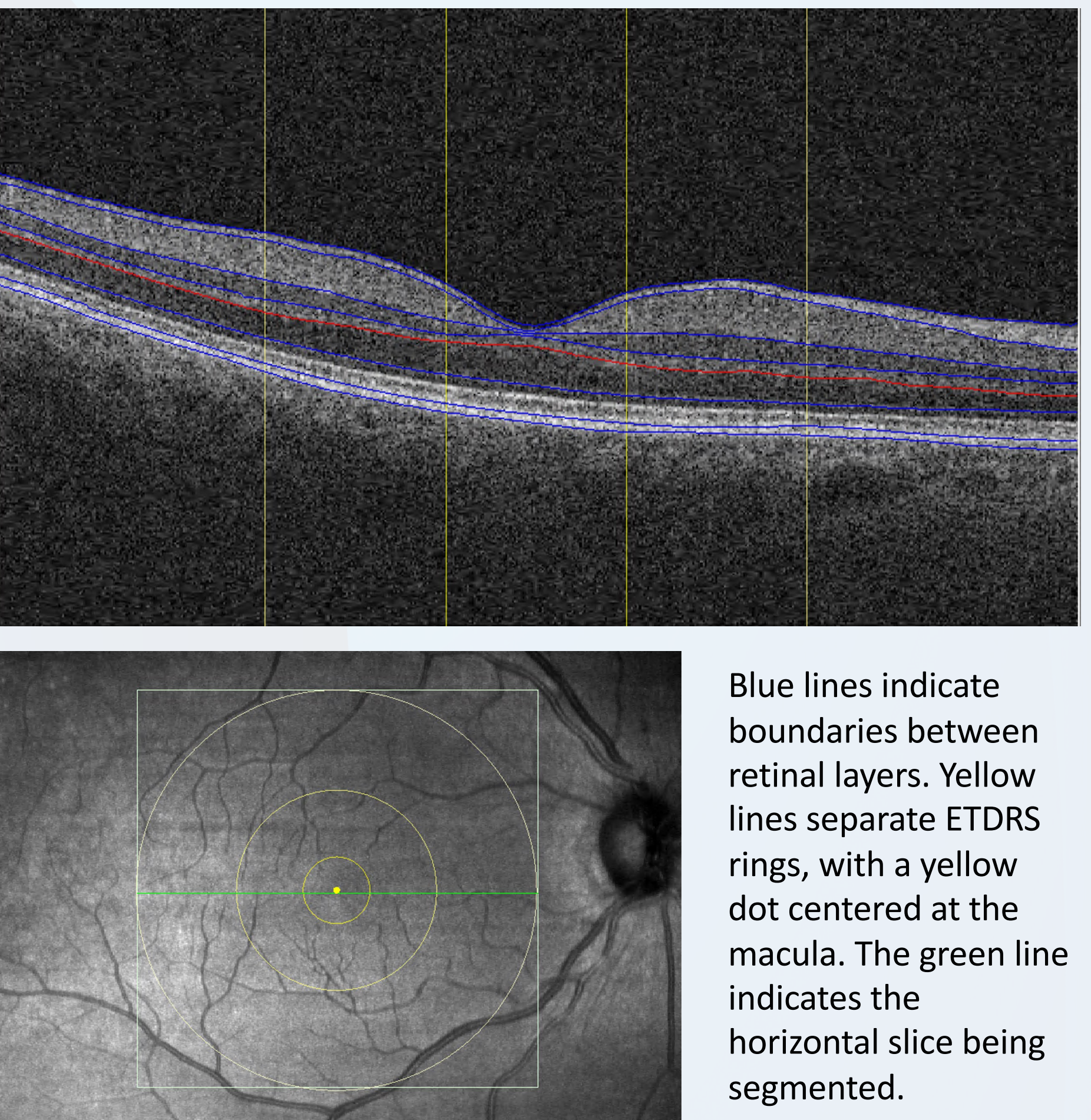


Table 2. Generalized Estimating Equations Results Comparing Retinal Layer Thicknesses in PD by HY Cluster in 6-mm ETDRS Ring.

Retinal Layer	Statistic	HY Cluster 1	HY Cluster 2	HY Cluster 3	Cluster 1 vs 2 P-value	Cluster 1 vs 3 P-value	Cluster 2 vs 3 P-value
Total retina, µm	N	15	47	9	0.26	0.09	0.20
	Mean (SD)	293.04 (16.04)	287.15 (10.60)	280.29 (9.08)			
	Min, Median, Max	272.99, 287.41, 321.79	244.65, 288.65, 310.33	264.95, 280.37, 292.02			
Ganglion cell - inner plexiform layer, µm	N	15	47	9	0.44	0.43	0.63
	Mean (SD)	62.69 (6.96)	60.56 (4.23)	59.00 (4.61)			
	Min, Median, Max	52.70, 64.73, 72.68	43.92, 60.13, 67.68	55.15, 58.96, 70.28			
Inner nuclear layer, µm	N	15	47	9	0.93	0.50	0.09
	Mean (SD)	30.04 (3.08)	30.02 (1.94)	29.03 (0.97)			
	Min, Median, Max	25.85, 30.50, 34.29	25.01, 30.23, 33.56	27.52, 29.16, 30.64			
Outer plexiform layer, µm	N	15	47	9	0.49	0.74	0.89
	Mean (SD)	24.52 (1.54)	24.81 (1.52)	24.53 (1.47)			
	Min, Median, Max	22.27, 24.51, 28.53	22.12, 24.62, 29.26	22.79, 24.18, 27.75			
Outer nuclear layer, µm	N	15	47	9	0.37	0.04	0.13
	Mean (SD)	58.57 (5.92)	57.23 (5.25)	54.44 (4.54)			
	Min, Median, Max	50.02, 60.17, 69.65	42.20, 57.45, 68.44	48.54, 52.64, 60.83			
Photoreceptor layer, µm	N	15	47	9	0.32	0.34	0.01
	Mean (SD)	50.12 (3.09)	51.78 (3.58)	48.98 (2.10)			
	Min, Median, Max	46.30, 49.65, 54.91	45.21, 51.31, 59.62	46.18, 48.73, 51.75			
Retinal pigment epithelium, µm	N	15	47	9	0.08	0.97	0.41
	Mean (SD)	25.34 (1.83)	24.00 (2.62)	26.02 (3.86)			
	Min, Median, Max	22.02, 25.21, 28.94	18.64, 23.99, 30.02	19.45, 25.19, 30.42			

Results

Figure 2. Sample Segmentation of Retinal Layers.



Conclusion

Early-stage PD (average HY stage 2.1 ± 0.7) was associated with a thicker INL, GC-IPL, and RPE compared to controls.

The PRL was thinner in the eyes of PD patients in HY stages 3-4 compared to the eyes of PD patients in HY stages 2-2.5. The ONL was thinner in the eyes of PD patients in HY stages 3-4 compared to the eyes of PD patients in HY stages 1-1.5.

These findings are compatible with a biphasic model of PD-related retinal changes, where initial tissue expansion is followed by tissue thinning.

References



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