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Letter to the Editor

Macular thickness in Chinese

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Editor,

Spectral-domain optical coherence tomography (OCT) has become a standard technique for examination of the retina and macula (Eriksson et al. 2009; Garcia-Martin et al. 2011; Golbaz et al. 2011; Holmström et al. 2010; Lima et al. 2011; Menke et al. 2011; Patel et al. 2011). Using the technique, we measured the macular thickness in healthy Chinese to obtain normative standard values for this ethnic group.

The prospective, cross-sectional observational study included healthy Chinese subjects, and the OCT examination was performed using the Spectralis® SD-OCT (Spectralis® OCT; Heidelberg Engineering, Heidelberg, Germany). Exclusion criteria were a best-corrected visual acuity lower than 20/20, a refractive error beyond ±6.0 diopters, and any ocular disease. Scan modes were the OCT star pattern and volume scan. Retinal thickness was measured automatically as the distance between the inner limiting membrane and the retinal pigment epithelium (RPE)–Bruch's membrane complex.

The study included 258 subjects with an age of 27.8 ± 13.7 years (range, 7–50 years) and mean axial length of 23.9 ± 1.1 m (21.47–27.16 mm) (Table 1). Mean minimal foveal thickness was 215 ± 14 μm, and central subfield thickness was 258 ± 19 μm. In the inner ring, the macular thickness was significantly ($p < 0.001$) the highest in the superior sector (344.4 ± 14.4 μm), followed by the nasal sector (342 ± 16 μm), the inferior sector (340 ± 15 μm) and the temporal sector (330 ± 14 μm). In the outer ring, the macular thickness was significantly highest ($p < 0.001$) in the nasal sector (319 ± 15 μm), followed by the superior sector (302 ± 14 μm), the inferior sector (289 ± 15 μm) and the temporal sector (287 ± 14 μm) (Fig. 1). The macular thickness measurements were significantly higher in men than in women in the fovea and the inner ring ($p < 0.001$). Adjusted for gender, the thickness measurements significantly increased with axial length in the fovea ($p < 0.001$) and decreased with higher axial length in the sectors of the inner and outer ring. For any location of measurement, an interocular difference of more than 5.5 μm was outside of the 95% confidence interval.

These retinal thickness measurements were by a factor of about 1.4:1 larger than the retinal thickness measurements obtained in the recent population-based Chinese Handan Eye Study (Duan et al. 2010). The reason for the differences in the measurements was probably due to differences in the OCT devices used (Handan Study: Stratus OCT, Model 3000; Zeiss-Meditec, Jena, Germany), as the Stratus® OCT uses the junction of the photoreceptor inner sectors and outer sectors as the posterior retinal border. In our study, thickness measurements in the fovea and in the outer ring were not related to age (Table 1). For the sectors in the inner ring, the macular thickness measurements increased with age. These results were unexpected, as histomorphometric studies showed an age-related decline in the number of retinal photoreceptors, RPE cells and retinal ganglion cell axons of about 0.3%/year of life (Jonas et al. 1992; Panda-Jonas et al. 1995, 1996). One has to consider that OCT measurements of macular tissue are based on the distance between the inner limiting

Table 1. Macular thickness measurements (μm; Mean ± standard deviations) as obtained by spectral-domain optical coherence tomography (Spectralis®) in 258 healthy Chinese subjects, stratified by age and sector of measurement.

	Age group (years)						Correlation coefficient *r*	p-value
	7–9	10–19	20–29	30–39	40–50	Total		
Number of Subjects	46	39	39	66	68	258		
Men/Women	24/22	16/23	14/25	25/41	34/34	113/145		0.86
Axial length (mm)	23.2 ± 0.8	24.6 ± 1.0	24.1 ± 1.0	23.7 ± 1.1	24.0 ± 1.1	23.9 ± 1.1	–	0.24
Refractive error (Diopters)	−0.24 ± 1.03	−2.59 ± 1.39	−2.12 ± 1.70	1.72 ± 1.82	1.47 ± 1.79	−1.59 ± 1.76	−0.18	0.02
Foveal minimum	211.1 ± 14.5	218.7 ± 13.2	216.9 ± 14.0	215.8 ± 12.0	215.1 ± 13.9	215.4 ± 13.6	–	0.50
Central fovea (1-mm Diameter)	254.2 ± 18.9	259.8 ± 18.8	255.8 ± 20.2	260.7 ± 20.3	257.7 ± 17.9	257.9 ± 19.2	–	0.54
Inner ring (3-mm Diameter)								
Superior	341.5 ± 11.2	340.2 ± 12.4	343.7 ± 13.5	349.7 ± 17.8	344.1 ± 12.8	344.4 ± 14.4	0.14	0.02
Inferior	336.7 ± 11.9	336.6 ± 13.7	337.7 ± 12.7	344.0 ± 17.7	339.9 ± 13.1	339.6 ± 14.5	0.15	0.02
Temporal	327.7 ± 12.4	326.5 ± 12.9	327.0 ± 12.5	334.5 ± 17.3	329.6 ± 12.5	329.7 ± 14.2	0.12	0.047
Nasal	327.7 ± 11.6	340.2 ± 14.6	340.2 ± 15.8	348.6 ± 18.4	342.3 ± 14.3	342.9 ± 15.6	0.11	0.07
Outer ring (6-mm Diameter)								
Superior	303.0 ± 14.7	298.1 ± 12.2	301.6 ± 11.6	305.3 ± 13.8	300.4 ± 13.9	301.9 ± 13.6	–	0.91
Inferior	291.2 ± 14.3	286.0 ± 12.2	289.9 ± 13.1	293.4 ± 17.0	285.8 ± 13.2	289.4 ± 14.6	–	0.47
Temporal	288.2 ± 13.8	282.7 ± 11.8	286.1 ± 11.7	288.9 ± 13.8	285.5 ± 17.7	286.5 ± 14.4	–	0.49
Nasal	319.2 ± 13.2	315.3 ± 13.6	316.4 ± 14.9	321.9 ± 16.8	316.8 ± 13.2	318.5 ± 14.6	–	0.85

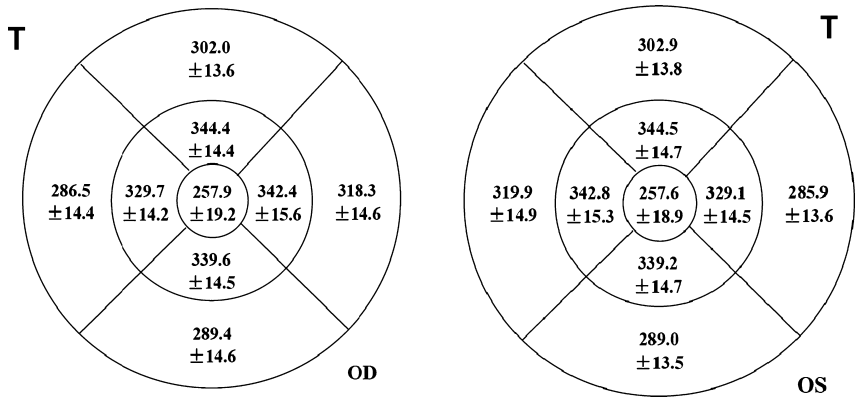

Fig. 1. Macular thickness measurements (μm; mean ± standard deviation) by optical coherence tomography (spectral-domain optical coherence tomography Spectralis) in healthy Chinese subjects. OD, right eye; OS, left eye; T, temporal side.

membrane and the RPE-Bruch's membrane complex and that they are thus no direct surrogate for the number of retinal cells. There may also be the possibility that the volume of the retinal cells increased with increasing age or that the number and volume of the glial system of the retina including microglial cells enlarged. It may have compensated or more than compensated a potential age-related loss of neural retinal cells. In addition, one has to take into account that our study included subjects with an age of maximal 50 years only. If the age-related loss of retinal cells occurs non-linearly with a steeper decline at higher age, the relatively low loss of retinal cells up to the age of 50 years may not have been noticeable by OCT measurements. The macular thickness measurements were higher in men than in women. It agrees with findings from the Handan Eye Study (Duan et al. 2010). Higher retinal thickness measurements in men than in women would fit with results from recent population-based studies in which the size of non-highly myopic eyes was related to body height and thus indirectly to gender (Nangia et al. 2010). Differentiated into various macular regions within the inner ring, the macular thickness was significantly ($p < 0.001$) the highest in the superior sector, followed by the nasal sector, the inferior sector, and finally the temporal sector. In the same sequence of sectors, the density of retinal pigment epithelium within the pericentral sector cells decreased in a previous histomorphometric study on the density and distribution of retinal photoreceptors and retinal pigment epithelium cells in human eyes (Panda-Jonas et al. 1996). In the outer ring in our study, the macular thickness was significantly highest ($p < 0.001$) in the nasal sector, followed by the superior sector, the inferior sector and the temporal sector. It again fits with the histomorphometric study (Panda-Jonas et al. 1996), in which the density of the retinal pigment epithelium cells decreased in the same sequence of nasal–superior–inferior–temporal.

References

Duan XR, Liang YB, Friedman DS et al. (2010): Normal macular thickness measurements using optical coherence tomography in healthy eyes of adult Chinese persons: the Handan Eye Study. Ophthalmology **117**: 1585–1594.

Eriksson U, Holmström G, Alm A & Larsson E (2009): A population-based study of macular thickness in full-term children assessed with Stratus OCT: normative data and repeatability. Acta Ophthalmol **87**: 741–745.

Garcia-Martin E, Pinilla I, Idoipe M, Fuertes I & Pueyo V (2011): Intra and interoperator reproducibility of retinal nerve fibre and macular thickness measurements using Cirrus Fourier-domain OCT. Acta Ophthalmol **89**: e23–e29.

Golbaz I, Ahlers C, Goesseringer N, Stock G, Geitzenauer W, Prünte C & Schmidt-Erfurth UM (2011): Automatic and manual segmentation of healthy retinas using high-definition optical coherence tomography. Acta Ophthalmol **89**: 185–189.

Holmström G, Eriksson U, Hellgren K & Larsson E (2010): Optical coherence tomography is helpful in the diagnosis of foveal hypoplasia. Acta Ophthalmol **88**: 439–442.

Jonas JB, Schmidt AM, Müller-Bergh JA, Schlötzer-Schrehardt UM & Naumann GO (1992): Human optic nerve fiber count and optic disc size. Invest Ophthalmol Vis Sci **33**: 2012–2018.

Lima VC, Prata TS, Castro DP et al. (2011): Macular changes detected by Fourier-domain optical coherence tomography in patients with hypotony without clinical maculopathy. Acta Ophthalmol **89**: e274–e277.

Menke MN, Dabov S, Knecht P & Sturm V (2011): Reproducibility of retinal thickness measurements in patients with age-related macular degeneration using 3D Fourier-domain optical coherence tomography (OCT) (Topcon 3D-OCT 1000). Acta Ophthalmol **89**: 346–351.

Nangia V, Jonas JB, Sinha A, Matin A, Kulkarni M & Panda-Jonas S (2010): Ocular axial length and its associations in an adult population of Central Rural India. The Central India Eye and Medical Study. Ophthalmology **117**: 1360–1366.

Panda-Jonas S, Jonas JB & Jakobczyk-Zmija M (1995): Retinal photoreceptor density decreases with age. Ophthalmology **102**: 1853–1859.

Panda-Jonas S, Jonas JB & Jakobczyk-Zmija M (1996): Retinal pigment epithelium cell count, density and correlations in normal human eyes. Am J Ophthalmol **121**: 181–189.

Patel PJ, Chen FK, Ikeji F & Tufail A (2011): Intersession repeatability of optical coherence tomography measures of retinal thickness in early age-related macular degeneration. Acta Ophthalmol **89**: 229–234.

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