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Original Article

Evaluation of retinal and choroidal thickness in various age groups

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Abstract

Aim: To evaluate retinal and choroidal thickness of healthy individuals in various age groups with optical coherence tomography (OCT) and enhanced depth imaging (EDI)-OCT technique .

Material and methods: Totally 149 healthy patients aged between 0 and 69 years from seven different decades were included in this study. The retinal and choroidal thickness of the central area (fovea) and of the nasal and temporal points at a distance of 1500 µm from this central point were measured in the right eye with an OCT device (Heidelberg, Germany) in all subjects. The subjects with any ocular or systemic pathology and the subjects with a spherical refractive error more than 3 D or a cylindrical refractive error more than 1 D were excluded. The measurements of right eyes of the subjects were used in the statistical analysis and the P value less than 0.01 was considered to be significant.

Results: The mean retinal thickness measurements were 326.61±16.89 µm at the temporally, 218.72±19.06 µm centrally and 351.32±17.74 µm nasally, with no statistically significant difference between the age groups ($p>0.01$). The mean choroidal thickness measurements were 299.01±72.38 µm temporally, 332.34±78.08 µm centrally and 258.30±71.80 µm nasally. There were statistically significant differences in central and temporal choroidal thickness between age groups ($p<0.01$).

Conclusion: A statistically significant decrease was present in the choroidal thickness but not in the retinal thickness with age.

Keywords: Retina; Choroid; Optical Coherence Tomography.

INTRODUCTION

The choroid was first evaluated histologically in the 17th century and then, efforts were made to image it. It extends from the ora serrata anteriorly to the optic nerve head posteriorly. The choroid layer is a vascular structure providing 85% of the ocular blood flow and is responsible for supplying the outer one third of the retina. A structural and functional intact choroid layer is required for healthy retinal functions to continue. Abnormal choroidal blood flow causes retinal receptor dysfunction and death, detailed and accurate identification of choroidal layer changes will allow the correct evaluation of several posterior segment disorders (1,2,3).

The posterior location of the choroid, the short wavelength of the used light, and the high reflectivity of the retinal pigment epithelium (RPE) prevent imaging the entire choroid by spectral domain optical coherence tomography (SD-OCT). It had therefore not been possible to image the entire choroid in high resolution with SD-OCT devices due to these problems until the OCT technology with the enhanced depth imaging (EDI) feature was developed (4). This EDI technique provides detailed information of the choroid by changing the zero delay point, the point of maximum OCT signal sensitivity (5). The approximation of the zero delay point to the choroid instead of the inner retinal layers increases detail in the choroidal images and thickness measurement can be performed with high reliability and repeatability (6).

In this study, we aimed to evaluate whether retinal and choroidal thickness change with age in healthy individuals by using SD-OCT and EDI-OCT technique.

MATERIAL and METHODS

This cross-sectional study was conducted at Ophthalmology Clinic of Abant Izzet Baysal University. A written informed consent was obtained from all participants. A total of 149 healthy individuals aged

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between 0 and 69 years from seven different decades were included in this study. The individuals were divided into seven groups according to their age. Each case underwent a detailed eye examination including uncorrected and best spectacle-corrected visual acuity (BSCVA) by the Snellen chart, intraocular pressure measurement, cycloplegic refraction, slit lamp and fundus inspection. The cycloplegic spherical equivalent (SE) of each individual was determined. Axial length (AL), the distance from the corneal vertex to the retinal pigment epithelium, was measured by the ultrasound in all individuals. A detailed history was obtained from all subjects and they were queried regarding a history of systemic disease and medications. Cases with chronic eye diseases such as corneal opacity or ocular surface disorder, glaucoma, uveitis, age-related macular degeneration, degenerative myopia, central serous chorioretinopathy and cases with a spherical refraction values over 3 diopters (D) and cylindrical refraction values over 1 D were not included in the study.

Retinal and choroidal measurements were performed in the right eye by the same researcher using an OCT device (Heidelberg Engineering, Heidelberg, Germany). The center was accepted as the area where the fovea was thinnest and the retinal and choroidal thickness values were first determined here. The retinal and choroidal thicknesses were also measured 1500 µm nasal and 1500 µm temporal to this point. Choroidal thickness measurements were performed manually based on the outer border of retinal pigment epithelium (RPE) and the outer border of choroidal vascular structure. The measurement results were presented as mean±standard deviation and the Anova test was used for the statistical analysis of the results. The statistical significance level was accepted as P<0.01.

RESULTS

A total of 149 healthy individuals were included in this study; 21 subjects (10 Male (M), 11 Female(F)) aged 0-9 years (mean 8.57±1.43), 20 subjects (10 M, 10 F) aged 10-19 years (mean 16.60±2.70), 21 subjects (11 M, 10 F) aged 20-29 years (mean 25.14±2.03), 21 subjects (11 M, 10 F) aged 30-39 years (mean 33.10±2.26), 20 subjects (10 M, 10 F) aged 40-49 years (mean 45.60±2.62), 21 subjects (11 M, 10 F) aged 50-59 years (mean 55.48±2.77), 25 subjects (14 M, 11 F) aged 60-69 years (mean 63.00±3.22).The best corrected visual acuities of the cases was 20/20 in the first five decades, 16/20 in the sixth decade, and 14/20 in the seventh decade. The mean age, AL and SE for all subjects were 36.15±19.27 years, 23.25±0.76mm and -0.03±2.21D, respectively. Central, nasal and temporal mean retinal thickness values for all subjects were 218.72±19.06µm, 351.32±17.74µm and 326.61±16.89µm, respectively, while the mean choroidal measurements were 332.34±78.08µm, 258.30±71.80µm and 299.01±72.38µm respectively. The mean SE, AL, and retinal and choroid thickness values in the age groups are presented in the Table 1.

Table 1. SE, AL, retinal and choroidal thickness in age groups

Age	0-9y	10-19y	20-29y	30-39y	40-49y	50-59y	60-69y
SE (D)	0.99±1.37	-0.56±0.97	-0.82±1.04	-0.55±0.82	-0.24±0.88	0.12±0.92	1.07±0.78
AL (mm)	22.70±0.77	23.32±0.89	23.68±0.69	23.49±0.83	23.28±0.52	23.12±0.61	23.18±0.70
Temp.r.thc. (µm)	324.62±14.00	332.20±13.13	322.52±18.62	330.81±22.23	326.65±15.74	326.10±22.03	324.12±0.47
Cent.r.thc. (µm)	220.58±21.23	214.50±11.53	213.86±13.64	221.43±17.01	214.45±11.21	217.57±19.62	226.76±28.51
Nas.r.thc. (µm)	352.33±12.92	355.20±17.13	348.57±15.79	352.14±24.40	351.55±18.16	355.52±20.39	345.28±13.58
Temp.c.thc. (µm)	273.52±75.63	337.75±71.42	298.10±59.03	332.62±54.92	327.55±69.70	273.33±72.84	260.72±64.98
Cent.c.thc. (µm)	312.62±83.43	358.40±84.00	312.52±67.90	375.14±59.90	355.25±82.93	319.57±87.38	301.16±55.92
Nas.c.thc. (µm)	252.86±61.51	281.25±70.10	244.52±66.14	293.67±64.80	275.10±73.16	240.95±80.46	227.48±69.01

SE: spherical equivalent, AL: axial length, Temp.r.thc.:temporal retinal thickness, Cent.r.thc.:central retinal thickness, Nas.r.thc.:nasal retinal thickness, Temp.c.thc.:temporal choroidal thickness, Cent.c.thc.:central choroidal thickness, Nas.c.thc.:nasal choroidal thickness,y:years

There was no statistically significant difference between the age groups in terms of SE or AL. The P values between the age groups for retinal thickness measurements from temporal to nasal were 0.478, 0.203, and 0.469, respectively, and these P values for choroidal thickness measurements were 0.000, 0.006, and 0.018, respectively. No statistically significant difference was found between the different age groups for retinal thickness measurements (P>0.01).

However, a statistically significant difference was found in central and temporal choroidal thickness measurements (P<0.01), the choroidal thickness was decreased with age.

DISCUSSION

The choroid is an intense vascular tissue, requiring in vivo imaging to determine its true thickness. Until recently, information about the choroidal thickness was based upon the histologic examinations, that don't accurately reflect the true measurements of this dynamic tissue. Recently, new advances in OCT software provided the chance to assess the choroidal thickness. Appropriate measurement of choroidal thickness using SD-OCT is possible with the EDI technique.

Choroidal thickness was first described by Margolis and

Spaide with the Spectralis device (Heidelberg Engineering, Heidelberg, Germany) and by Manjunath et al. with the Cirrus HD-OCT device (Carl Zeiss Meditec, Dublin, CA, USA) (7,8). The choroidal thickness is determined by manually measuring the perpendicular distance between the hyper reflective outer edge of RPE and the inner edge of the choroid-sclera junction. Determining the choroid-sclera junction is not always possible and it is therefore recommended to obtain as clear images as possible. Black on white, white on black or color OCT images are recommended (9). The choroidal layer was found to be the thickest under the fovea (to meet the high oxygen requirement) and thinner at the nasal retina compared to the temporal retina (9).

Our aim in this study was to evaluate whether retinal and choroidal thickness change with age in healthy individuals by using SD-OCT and EDI-OCT technique. No statistically significant difference between the age groups was found for retinal thickness measurements but a statistically significant difference was found for central and temporal choroidal thickness. The choroidal thickness was decreased in these points with age.

There are similar studies on different populations in the literature. Goldenberg et al. evaluated choroidal thickness subfoveally and in the superior, inferior, nasal and temporal quadrants at a distance of 3 mm to the fovea with OCT in the 84 eyes of 42 healthy individuals and reported a statistically significant negative correlation between choroidal thickness and age, AL and refractive errors (10). Margolis et al. concluded that choroidal thickness had a negative correlation with age in their study on the 54 eyes of 30 patients (7).

Gok et al. measured subfoveal choroidal thickness (SCT) in 478 eyes of 239 healthy individuals aged 10 to 83 years using the EDI mode of OCT and found a statistically significant negative correlation between SCT measurements and age. They reported a decrease of 1.797μm in the mean SCT value for an increase of one year of age on regression analysis (11).

Wakatsuki et al.assessed choroidal thickness in 115 normal eyes of 115 healthy subjects aged 21 to 85 years using swept-source optical coherence tomography (SS-OCT). They concluded that total choroidal thickness diminishes with age, with the subfoveal choroidal thickness decreasing by 2.98μm per year (12).

Fujiwara et al. measured macular choroidal thickness in highly myopic eyes (≥6 D) using EDI-OCT and found that subfoveal choroidal thickness diminished by 12.7 μm for each decade of life and by 8.7 μm for each D of miyopia (13).

In another study Tuncer et al. investigated the associations between choroidal thickness and gender, age, refractive error, and AL in 154 eyes of 154 healthy Turkish subjects by using SD-OCT. They reported that choroidal thickness decreases with increasing myopia, age, and AL (14).

All of these aforementioned instrumental studies' results are consistent with those from our study. Histopathologic choroidal thickness analyzes of postmortem and eye bank samples also show a progressive decrease in choroidal thickness with aging (15). Histologic studies similarly show a reduced choriocapillaris layer with aging (16). Although there are not enough studies on the pathophysiology of this age-related change in the choroidal microvascular system, it is probable that its vascular structure changes with aging as seen in other microvascular tissues of the body (17).

One limitation of our study is that the reduction in choroidal thickness for each year or decade was not exactly established.

CONCLUSION

In conclusion, our study showed that aging did not affect the retinal thickness while reducing the choroidal thickness. Further histopathological studies are required to confirm these results.

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