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Association between choroidal vascular density, age and sex: A prospective study

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ABSTRACT

Objective: To evaluate choroidal vascular density changes in regards to age and sex.
Methods: This was a prospective, cross-sectional, study. We studied 78 volunteers. All participants underwent a complete ophthalmologic examination and assessment of the choroidal vascular density (CVD) using swept-source optical coherence tomography (SS-OCT). CVD obtained by automated software of the SS-OCT. We evaluated the CVD correlation with age and compared female to male.
Results: The study included 78 right eyes of 78 individuals: 40 females and 38 males. The participants' age and the CVD were significantly correlated ($r = -0.39$, $p < 0.001$). The mean CVD of the females and males were 0.26 ± 0.08 and 0.23 ± 0.05, respectively ($p = 0.03$).
Conclusion: CVD was found to be associated with age and sex

The assessment of choroidal changes is important for understanding the pathology of and treatment for chorioretinal diseases [1]. Choroidal thickness (CT) has been widely studied [2–4]. CT is associated with choroidal diseases like Vogt-Koyanagi-Harada, polypoidal choroidal vasculopathy and pachychoroid disease. Also, ageing is associated with choroidal thickness [5–7]. Choroidal vascular density(CVD) is a new parameter assessed with patients. CVD could give information about the ethiology of CT changes with choroidal diseases. The purpose of this study was to investigate CVD changes with ageing.

1. Subjects and methods

1.1. Study design

This prospective, cross-sectional, comparative study was performed in 2017. The study adhered to the tenets of the Declaration of Helsinki and was approved by the ethics committee at Bakirkoy Education and Research Hospital. All participants were volunteers. Informed consent was provided by all participants.

1.2. Ophthalmic examination

All participants underwent an ophthalmologic examination that included refraction, visual acuity, slit-lamp biomicroscopy, Goldmann applanation tonometry, and dilated fundoscopy by one specialist (E.E).

Optical coherence tomography (OCT) [Swept Source OCT DRI OCT Triton, Topcon] images were taken from right eyes and assessed by an experienced specialist (E.E.) [Fig. 1]. Fifteen minutes before the examination, the pupils were dilated with 1% tropicamide (Alcon, Denmark). Swept-source OCT uses a wavelength of 1050 nm with a scan speed of 100,000 A-scans / second coupled using the SMART track eye tracking system. 6×6-mm subfoveal scan size images with a resolution of 320×320 were obtained and flattened Bruch membrane. To take quantify CVD version 1.0.1 (Topcon Corporation) and version 1.48 (National Institutes of Health, Bethesda, Maryland, USA). softwares were applied. The average of the macular CVD between Bruch's membrane and corresponding to the maximal CT was calculated from the 6 mm diameter circular macular region centered on the fovea.

1.3. Study groups

We recruited 78 participants examined at the Beyoglu Eye Training and Research Hospital without any visual disorder, ocular or systemic diseases.

1.4. Eligibility criteria

The inclusion criteria required volunteers who had not consumed any alcohol in the previous year and had not taken any medications in the previous 4 months.

Exclusion criteria were a history of any ocular disease or any systemic disease with ocular findings, previous ocular surgery, laser

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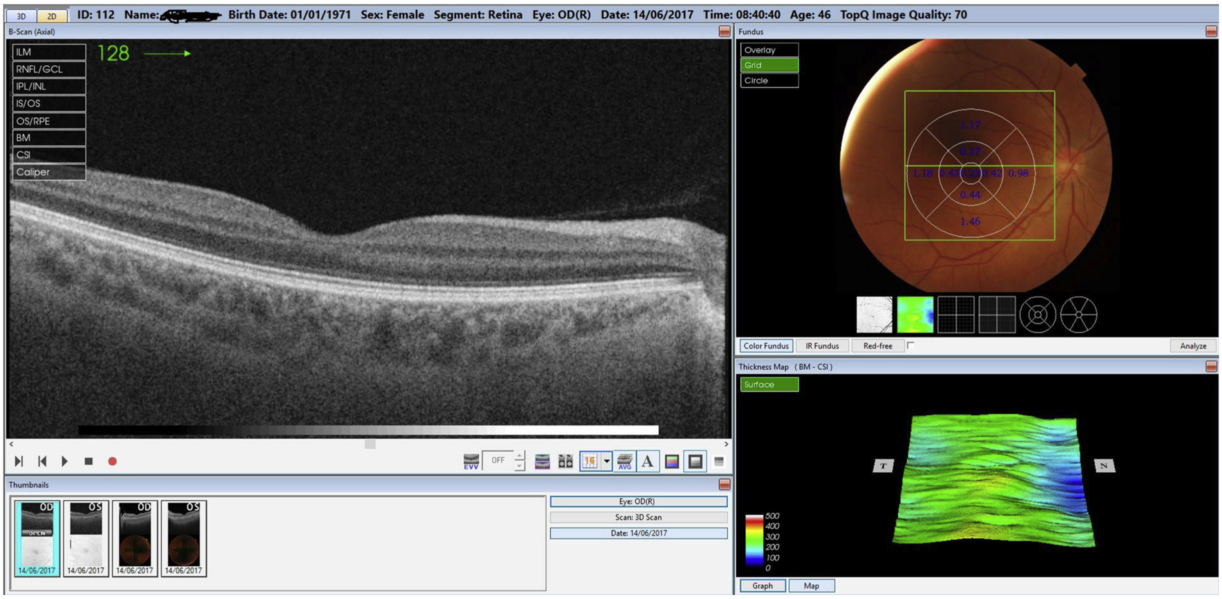

Fig. 1. Subfoveal choroidal density with optical coherence tomography angiography (SS-OCT) [Swept Source OCT DRI OCT Triton, Topcon].

therapy, use of any systemic medicine or contraceptive during the previous 4 months and smoking.

1.5. Outcome measures

The primary outcome of this study was the correlation of CVD changes with ageing. The secondary outcome was to evaluate CVD by sex.

1.6. Data analysis

Results are expressed as mean ± standard deviation of the mean. The correlation between the demographic characteristics and choroidal density was analyzed using Pearson's correlation test. E-PICOS software (New York) was used for data analysis and p values of < 0.05 were considered statistically significant.

2. Results

The study included 78 eyes of 78 individuals: 40 females and 38 males. The mean age of the patients was 34.43 ± 1.83 years. Thirty-eight of the volunteers were over 40-year-old (20 females and 18 males), forty of the volunteers were under 40-year-old (20 females and 20 males) and twenty of the volunteers under 18-year-old (16 females and 4 males). The mean foveal CVD of patients aged under 18, 18–40 and over 40 years were 0.29 ± 0.08, 0.23 ± 0.04 and 0.23 ± 0.06, respectively. The participants' age and choroidal density were significantly correlated ($r = -0.39$, $p < 0.001$) [Fig. 2]. The mean choroidal density of the females and males were 0.26 ± 0.08 and 0.23 ± 0.05, respectively ($p = 0.039$).

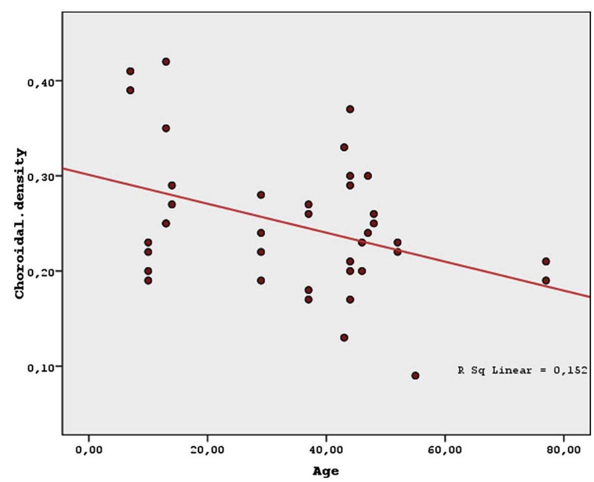

Fig. 2. Correlation between age and subfoveal choroidal density. ($r = -0.39$, $p < 0.001$).

3. Discussion

In this study, we compared CVD based on participants of different ages and we reported CVD changed with sex and age.

Wakatsuki et al. assessed choroidal thickness of 115 eyes with different age groups at five sites (the fovea, and superior, inferior, nasal, and temporal sites) using swept-source OCT and found that choroidal thicknesses at each site was related to the subject's age ($p < 0.001$) and the choroid became significantly thinner with ageing [7]. In addition, Varsha et al. reported a correlation between mean subfoveal choroidal thickness and age ($r = -0.61$, $p < 0.001$) [9]. Moreover, Bafiq et al. showed an age-dependent decline in choroidal thickness of 2 mm per year of age [6]. In the present study, the mean foveal CVD of patients aged under 18 years was 0.29 ± 0.08 and of those aged over 18 years it was 0.23 ± 0.06. The participants' age and the CVD were significantly correlated ($r = -0.39$, $p < 0.001$). Decreased choroidal thickness with age that was in our findings consistent with the literature [6]. Medrano et al. also reported there were higher CVD with participants under 18-year-old [8]. The thinning of the choroid probably may not only be related with only extracellular fluid loss otherwise the CVD would be expected to increase.

There are studies that show variability in choroidal thickness in healthy eyes according to sex [9,10,6]. But, Medrano et al revealed that there was no relation with gender and CVD [8]. In our study, the sex distribution of the participants was nearly equal (40 females and 38 males) and the CVD of the females was statistically significantly higher than the males. It could be seen as a consequence of sex hormone effects on body fluid regulation. Also, it has been shown that choroidal thickness is affected by the diurnal period [11,12]. Accordingly, all our measurements were performed between 08:30 AM and 10:30 AM. Other factors that have been reported to affect choroidal thickness are taking caffeine [13–15] and smoking [16,17]. In order to control for these parameters, we scanned all participants before they had breakfast and ensured that each was a non-smoker.

The main strength our study is its prospective nature. Other strengths are having a large number of participants, and using a new technology that has not been widely studied issue.

In conclusion, subfoveal CVD was related to ageing and sex. Subfoveal CVD significantly decreased with ageing and high with females. Therefore, with our study, we hope to draw the attention of physicians and inspire further studies to identify the mechanism of these changes.

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Contributors

EE: conceived and designed the study; EE: were involved in patient care; EE: collected the data; EE: analysis and interpretation of data; EE: drafting the manuscript; EE: design of the work, revising the work critically for important intellectual content; EE approved the final version of manuscript.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committee with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Declaration of Competing Interest

All authors have no financial interests to disclose.

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Text checked by a native speaker.

References

[1] D.L. Nickla, J. Wallman, The multifunctional choroid, Prog. Retin. Eye Res. 29 (2) (2010) 144–168, https://doi.org/10.1016/j.preteyeres.2009.12.002.
[2] E.D. Aygit, I. Yilmaz, A. Ozkaya, Z. Alkin, B. Gokyigit, A.T. Yazici, A. Demirok, Choroidal thickness of children's eyes with anisometropic and strabismic amblyopia, J. AAPOS 19 (3) (2015) 237–241, https://doi.org/10.1016/j.jaapos.2015.03.013.
[3] L. Niyaz, O.E. Yucel, N. Ariturk, O. Terzi, Choroidal thickness in strabismus and amblyopia cases, Strabismus 25 (2) (2017) 56–59.
[4] A. Kaderli, M.A. Acar, N. Unlu, G.O. Uney, F. Ornek, The correlation of hyperopia and choroidal thickness, vessel diameter and area, Int. Ophthalmol. 38 (2) (2018) 645–653.
[5] T. Nishi, T. Ueda, T. Hasegawa, K. Miyata, N. Ogata, Choroidal thickness in children with hyperopic anisometropic amblyopia, Br. J. Ophthalmol. 98 (2) (2014) 228–232.
[6] R. Bafiq, R. Mathew, E. Pearce, A. Abdel-Hey, M. Richardson, T. Bailey, S. Sivaprasad, Age, sex, and ethnic variations in inner and outer retinal and choroidal thickness on spectral-domain optical coherence tomography, Am. J. Ophthalmol. 160 (5) (2015) 1034–1043 e1031.
[7] Y. Wakatsuki, A. Shinojima, A. Kawamura, M. Yuzawa, Correlation of aging and segmental choroidal thickness measurement using swept source optical coherence tomography in healthy eyes, PLoS One 10 (12) (2015) e0144156.
[8] J. Ruiz-Medrano, J.M. Ruiz-Moreno, A. Goud, K.K. Vupparaboina, S. Jana, Chhablani J: age-related changes in choroidal vascular density of healthy subjects based on image binarization of swept-source optical coherence tomography, Retina 38 (3) (2018) 508–515.
[9] V. Manjunath, M. Taha, J.G. Fujimoto, J.S. Duker, Choroidal thickness in normal eyes measured using Cirrus HD optical coherence tomography, Am. J. Ophthalmol. 150 (3) (2010) 325–329 e321.
[10] S.W. Kim, J. Oh, S.S. Kwon, J. Yoo, K. Huh, Comparison of choroidal thickness among patients with healthy eyes, early age-related maculopathy, neovascular age-related macular degeneration, central serous chorioretinopathy, and polypoidal choroidal vasculopathy, Retina 31 (9) (2011) 1904–1911.
[11] S.W. Lee, Seo K.H. Yu SY, E.S. Kim, H.W. Kwak, Diurnal variation in choroidal thickness in relation to sex, axial length, and baseline choroidal thickness in healthy Korean subjects, Retina 34 (2) (2014) 385–393.
[12] O.A. Osmanbasoglu, Z. Alkin, A. Ozkaya, Y. Ozpinar, A.T. Yazici, A. Demirok, Diurnal choroidal thickness changes in normal eyes of Turkish people measured by spectral domain optical coherence tomography, J. Ophthalmol. 2013 (2013) 687165.
[13] M.O. Zengin, E. Cinar, E. Karahan, I. Tuncer, C. Kucukerdonmez, The effect of caffeine on choroidal thickness in young healthy subjects, Cutan. Ocul. Toxicol. 34 (2) (2015) 112–116.
[14] M.S. Dervisogullari, Y. Totan, A. Yuce, A.E. Kulak, Acute effects of caffeine on choroidal thickness and ocular pulse amplitude, Cutan. Ocul. Toxicol. 35 (4) (2016) 281–286, https://doi.org/10.3109/15569527.2015.1104330.
[15] H. Altinkaynak, E. Ceylan, B. Kartal, S. Keles, M. Ekinci, O.O. Olcaysu, Measurement of choroidal thickness following caffeine intake in healthy subjects, Curr. Eye Res. 41 (5) (2016) 708–714.
[16] S. Sizmaz, C. Kucukerdonmez, E.Y. Pinarci, A. Karalezli, H. Canan, G. Yilmaz, The effect of smoking on choroidal thickness measured by optical coherence tomography, Br. J. Ophthalmol. 97 (5) (2013) 601–604.
[17] F. Ulas, F. Celik, U. Dogan, S. Celebi, Effect of smoking on choroidal thickness in healthy smokers, Curr. Eye Res. 39 (5) (2014) 504–511.