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Subfoveal Choroidal Thickness in Relation to Axial Length and Refractive Errors in Adults Aged 20-40

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Abstract
Aim: The aim of this study is to investigate the association between subfoveal choroidal thickness, ocular axial length, and refractive errors in healthy adults.
Materials and Methods: A hundred eyes of 50 patients were included in this study. A full ophtalmic examination including best corrected visual acuity, refractive levels, and interferometric ocular axial length was applied to all the patients. The submacular choroidal was imaged using enhanced depth imaging spectral domain optical cohorence tomography. Subfoveal choroidal thickness was measured by two diifferent experts using visual inspection and manual fitting of the choroidal borderlines.
Results: Of the 50 subjects, 24 were males and 26 were females. The results of the applied measurements were as follows: mean age: 28,9(±6,8); visual acuity: 0,95±0,16; mean subfoveal choroidal thickness: 302,64µm(±52,07); mean axial lentgh: 23,59mm(±0,94); mean intraoculer pressure 14,5±2,3; and mean spheric equivalent -0,47(±0,97). No significant difference between males and females was observed in terms of mean subfoveal choridal thickness. Multivariable linear regression suggested that age was not associated with subfoveal choroidal thickness (r=-0,247; p=0,106). There was no correlation between axial length and subfoveal choroidal thickness either (r=-0,128; p=0,234). There was, however, a positive correlation between spheric equivalents and subfoveal choroidal thickness (r=0,227; p=0,033).
Conclusion: In this study, we found that subfoveal choroidal thickness was significantly associated with spheric equivalent while there was no association between axial length and subfoveal choroidal thickness. We also observed that there was no difference between males and females with regards to subfoveal choroidal thickness.
Keywords: Choroidal Thickness; Axial Length.

20 -40 Yaş Arası Erişkinlerde Subfoveal Koroidal Kalınlığın Aksiyel Uzunluk ve Refraksiyon Kusuru ile İlişkisinin İncelenmesi

Özet
Amaç: 20-40 yaş arası sağlıklı erişkinlerde subfoveal koroidal kalınlık ile aksiyel uzunluk, refraksiyon kusuru arasındaki ilişkiyi incelemek.
Gereç ve Yöntemler: Çalışmaya 50 sağlıklı bireyin 100 gözü dahil edildi. Çalışmaya katılan bireylerin en iyi düzeltilmiş görme keskinlikleri, refraksiyon değerleri, göz içi basınçları, interferometrik aksiyal uzunluk ölçümlerini içeren tam oftalmolojik muyaneleri yapıldı. Subfoveal koroidal kalınlık ölçümü; optikal koherens tomografi(OKT) ile koryokapilleris yapısının sınırlarının görsel ve işaretleme yöntemi kullanılarak iki ayrı kişi tarafından yapıldı.
Bulgular: Çalışmaya dahil edilen bireylerin 24'ü kadın, 26'sı erkek ve ortalama yaşı 28,9(±6,8)'idi. Görme keskinlikleri 0,95±0,16; ortalama subfoveal koroidal kalınlık 302,64µm(±52,07); ortalama aksiyel uzunluk 23,59mm(±0,94); göz içi basınçları 14,5±2,3; ortalama sferik ekivalanı -0,47(±0,97)' idi. Erkek bireylerde ortalama subfoveal koroidal kalınlık 306,25µm(±61,9), kadınlarda 306,13µm(±58,9) Ortalama yaş ile subfoveal koroidal kalınlık arasında anlamlı bir ilişkiye rastlanılmadı.(r=-0,247, p=0,106) Subfoveal koroidal kalınlık ile aksiyel uzunluk arasında anlamlı bir ilişki yok iken (r=-0,128, p=0,234) subfoveal koroidal kalınlık ile sferik ekivalan arasında pozitif yönde anlamlı bir ilişki vardı.(r=0,227, p=0,033)
Sonuç: Bu çalışmada genç sağlıklı erişkinlerde ortalama subfoveal koroidal kalınlığın erkek ve kadın bireyler arasında farklı olmadığı görüldü. Subfoveal koroidal kalınlık ile aksiyel uzunluk arasında anlamlı bir ilişki bulunmazken, sferik ekivalan arasında pozitif yönde ilişki mevcuttu.
Anahtar Kelimeler: Koroidal Kalınlık; Aksiyel Uzunluk.

INTRODUCTION

Choroid layer is an important layer of vessels that nourishes outer retina. Choroid has many important functions in several processes such as retinal temperature regulation, the development of the sclera, and the stabilisation of retinal position (1). Choroid layer is one of the most densely vascularised structure in human body (2). Choroidal thickness may vary according to the presence of different chorioretinal disorders (3, 4). However, several studies have shown that chorioretinal changes caused by increased axial length in degenerative myopia patients can be associated with thinner choroidal thickness while choroidal thickness is larger in patients with hyperopia than people with healthy eyes (5, 6).

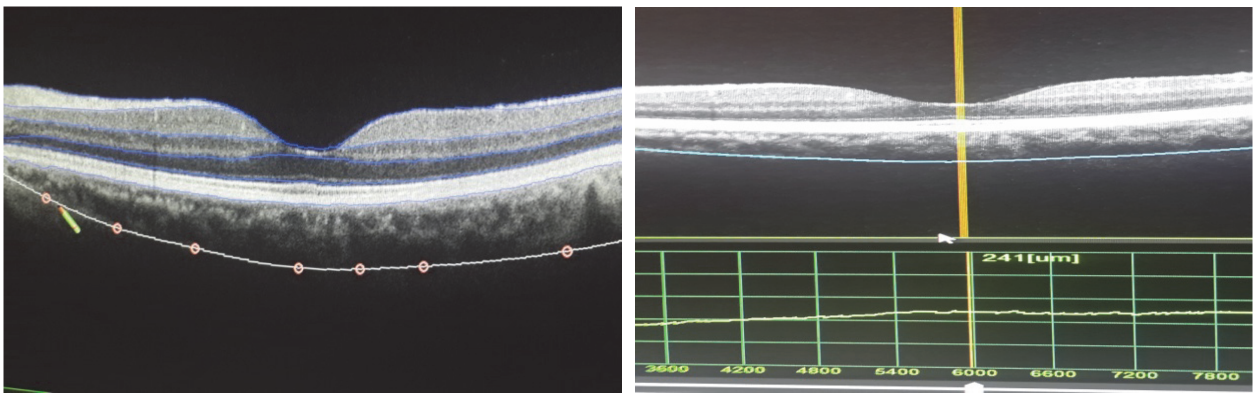
Although B-mode ultrasound imaging, one of the current imaging techniques, is, albeit partially, used in identifying thickness of the choroid layer, indocyanine angiography can only be used in imaging of the vascular structures of the choroid layer. As one of the recent imaging methods used in imaging the deep choroidal layer, optical coherence tomography (EDI-OCT) allows the measuring choroidal layer thickness in the subfoveal and peripheral areas by taking cross-section images of the choroid layer (7). In this study, we aim to determine the average subfoveal choroidal thickness values of a young adult group of patients by using spectral OCT-EDI and to establish the relationship between these values and variables like gender, age, axial length, and spherical equivalent.

MATERIALS and METHODS

The study includes both eyes of 50 healthy subjects between 20-40 years of age. We received informed consent forms, which are in accordance with the Declaration of Helsinki, from the individuals. We applied full ophthalmic examinations, including anterior segment and dilated funds examinations, for all the patients. Individuals with glaucoma, ocular trauma, amblyopia, history of ocular surgery, retinal abnormalities and choroidal pathologies, and a refractive error of >+/- 6 were excluded from the study. In addition, patients with systemic diseases that affect retinal and choroid circulation such as hypertension and diabetes were also excluded.

We measured the spherical equivalent values of the individuals with an auto refractometer (RK-3, Canon, Tokyo, Japan); we used IOL Master (Carl Zeiss Meditec, Dublin, CA) to measure axial lengths and a Goldman applanation tonometry for intraocular pressure measurement. To measure the subfoveal choroidal layer thickness with a spectral-domain OCT (SD-OCT, RS-3000, Nidek, Gamagori, Japan). The measurements were made independently by two different practitioners. After manually marking the region between the outer part of the retinal pigment epithelium (RPE) and corneoscleral interface, we automatically measured subfoveal choroidal layer thickness by using an OCT (Figures 1 and 2).

Figures 1 and 2: Measuring subfoveal choroidal thickness with OCT.



STATISTICAL ANALYSIS

To analyse the compliance of the numerical values with the normal distribution we made of the Kolmogorov-Smirnov test. The data that matched with the normal distribution were summarised with mean and standard deviation values. The data that did match with the normal values were summarised in median, minimum, and maximum values; at this stage, independent groups were applied the Mann-Whitney U test and dependent groups were compared by using the Wilcoxon test. Relationships between variables were analyzed with the Spearman rank correlation coefficient. The level of significance was accepted as 0,05 for all analyses.

RESULTS

Of the 50 individuals who participated in the study, 24 were males and 26 were females; the mean age of the patients was 28,9 (±6,8). The best corrected visual acuity value was 0,95± 0,16; the mean intraocular pressure was 14,5±2.3; the mean spherical equivalent was 0,47 (±0,97); the mean subfoveal choroidal thickness was 302,64µm (±52,07); and the average axial length was 23,59mm (±0,94) (Table 1).

Table 1: Demographical and coular characteristics of the individuals included in the study.

Mean age	28,9 (±6,8)
Mean axial length	23,59mm (±0,94)
Mean spherical equivalent	-0,47 (±0,97)
Gender	24M; 26F
Best corrected visual acuity value (according to the Snellen scale)	0,95±0,16
Mean intraocular pressure	14,5±2,3 mmhg
Mean subfoveal choroidal thickness	302,64µm (±52,07) range=(124-587 µm)

The average subfoveal choroidal thickness for males was 306,25µm (±61,9); this value was 306,13µm (±58,09) for female subjects. There was no difference between males and females in terms of choroidal thickness (P=0,995) (Table 2).

Table 2: Subfoveal choroidal thickness according to gender.

	Males	Females	p
Mean subfoveal choroidal thickness	306,25µm (±61,9)	306,13µm (±58,09)	0,995

For all the patients, both eyes were included in the study and choroidal thickness measurements were performed separately for each eye. The average choroidal thickness in the right eyes of the subjects was 296μ (min: 220; max: 476); this value was 296μ (min: 216; max: 395) for the left eyes; and there was no significant difference between the right and left eyes in terms of choroidal thickness (P=0,388) (Table 3).

Table 3: Choroidal thickness difference between the right and left eyes.

	Right eye	Left eye	p
Mean subfoveal choroidal thickness	296μm(min:220, max:476)	296μm(min:216, max:395)	0,388

Throughout the research, we also studied the relationship between average choroidal thickness and axial length, as well as the relationship between spherical equivalent values and age of the patients (Table 4). There was no significant relationship between average subfoveal choroidal thickness, axial length, and age (r-0,128, p=0,234) though there was a positive correlation between these variables and spherical equivalent (R=0,227; p=0,033).

Table 4: The relationship between subfoveal choroidal thickness, age, and axial length.

	Mean subfoveal choroidal thickness
Mean axial length	r=-0,128, p=0,234
Mean spherical equivalent	r=0,227, p=0,033
Age	r=-0,247, p=0,106

DISCUSSIONS

The choroid layer is the most vascularised layer of the eye and its main function is provide nutrients and oxygen to the outer part of the retina. In addition to our knowledge of this primary task of the choroidal layer, researchers, especially after the recently developed imaging techniques like EDI-OCT, have begun to consider a possible relationship between choroid layer and other parameters of the eye and dealt with the place of thickness of the choroid layer in ocular physiology with a better understanding (8, 9). It has been observed from the tests on choroid layer thickness in animals that the layer thickness decreases towards the periphery (10).

After their assessment of choroidal thickness in 34 healthy individuals, Margolis and Spaide have found that the average subfoveal choroidal thickness was 287±76μm with a significant difference between subfoveal choroid layer and extrafoveal choroid layer in terms of thickness (9). Ikon et al.'s study on 43 healthy Japanese individuals has reported an average subfoveal choroidal thickness of 354±111μm and shown that there can be a difference only if the comparison is a horizontal comparison; they believe that such a difference in values will not surface in case of a vertical comparison (11). Xiao Qiang Li et al.'s study on college students has reported an average subfoveal choroidal thickness of 342 (±118) μm (12).

In our study, we examined both eyes of 50 young adults between the ages of 20 and 40 and found a mean subfoveal choroidal layer thickness value of 302,64μm. We measured both eyes in each individual and observed no differences between the left and right eyes in the same individuals. When we compared our results with those of other studies, we found out that there were occasional similarities as well as differences in terms of subfoveal choroidal thickness values. We are of the opinion that this was because of several ocular parameters concerning choroidal thickness such as axial length and refraction. Depending on gender, axial length, intraocular pressure, and retinal thickness can vary in several studies (13, 14). Studies on animal and humans have shown that sex steroids are found in the retina and retinal pigment epithelium (15); in fact, a study on human choroid layer has even concluded that choroid layer contains a subtype of the oestrogen receptor (16). Because of these findings, it can be thought that sex steroids affect choroidal circulation and cause variations on choroidal thickness depending on gender (17, 18). Studying the average subfoveal choroidal thickness on men and women, we could not find any significant difference between sexes (Table 2).

One of the important parameters affecting choroidal thickness is the age. Histological studies have shown that choroidal thickness may decrease by 80μm by the age of 90 (19). Ding et al.'s study has reported that choroidal thickness gets thinner and decreases in patients older than 60 while this condition is not applicable to people younger than 60 (20). Because our study was not conducted among subjects of different age groups but among young adults only, we were unable to identify how choroidal thickness change with age. We simply analysed the relationship between mean age and choroidal thickness between which we could not detect any significant difference.

In addition to various structural changes in the retina, increase in axial length also leads to a decrease in retinal function (21). Similarly, some studies argue that increase in axial length decreases choroidal thickness while increased degree of myopia results in thinner choroid layer (20, 21). In our study, we did not come across any significant correlation between average axial length and choroidal thickness. We think that this was because the number of individuals participating in the study were not many and they had a limited age range.

Thinned choroidal thickness due to high axial length and increased axial myopia trigger this medical picture, which suggests the relationship between ocular refraction and choroidal thickness. Therefore, the relationship between refractive error of the eye and choroidal thickness gains importance. The most important of these parameters is the spherical equivalent. Spherical equivalent is not stable during lifetime; it continuously changes. Changes in corneal thickness due to ageing, age-related increase of cataracts that leads to myopic changes, and reduction in corneal curvature can be regarded as some of the reasons behind this condition. Different correlations between choroidal thickness and spherical equivalent in different age groups also occur because of these reasons (22). Min Kim et al.'s study has shown that there is a significant difference between refraction and choroidal thickness in people below the age of 60 while this correlation is not observed in people older than 60 (23). We observed a similar relationship between mean spherical equivalent and choroidal thickness in our study (Table 4).

Simply put, we came to the conclusion that there is a positive correlation between subfoveal choroidal thickness and spherical equivalent refraction in young healthy while, unlike other studies, there is no significant relationship between axial length, age, gender, and subfoveal choroidal thickness. We think that this was because we conducted our study on a limited number of patients with a narrow age range. It can be concluded that there is need for larger prospective studies which do not only measure subfoveal properties but encompass choroidal thickness in extrafoveal areas in order to have a better understanding of the pathogenesis of choroidal thickness related choroidal and retinal diseases.

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