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ORIGINAL PAPER

Choroidal thickness in psoriasis

Raşit Kılıç · Ali Kurt · Ersoy Acer · Çağlar Öktem · Özkan Kocamış

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Abstract Our aim was to compare the choroidal thickness in psoriasis patients and age- and gender-matched healthy volunteers. A total of 38 psoriasis cases and 38 age- and gender-matched controls were evaluated. The left eye was evaluated in all subjects. The choroidal thicknesses were measured at the subfovea and horizontally across the fovea at 500-μm intervals using enhanced depth imaging spectral domain optical coherence tomography. The points of measurement were 1500 μm temporal and nasal to the fovea. Choroidal thicknesses in psoriasis patients were thicker than those in the controls, but these differences were not statistically significant ($P > 0.05$). A positive correlation was present between the duration of disease and choroidal thickness at certain measurement points, but there was no significant correlation between the Psoriasis Area and Severity Index score and choroidal thickness. There was no significant difference between psoriasis patients and healthy controls in terms of choroidal thickness. However, choroidal thickness was associated with disease duration.

Keywords Choroidal thickness · Enhanced depth imaging · Optical coherence tomography · Psoriasis

R. Kılıç (✉) · A. Kurt · Ö. Kocamış
Department of Ophthalmology, Faculty of Medicine, Ahi Evran University, Bağbaşı, Sahir Kurutluoğlu Cad. No:100, 40100 Kırşehir, Turkey
e-mail: kilicrasit@gmail.com

E. Acer
Department of Dermatology, Ahi Evran University Training and Research Hospital, Kırşehir, Turkey

Ç. Öktem
Department of Ophthalmology, Ahi Evran University Training and Research Hospital, Kırşehir, Turkey

Introduction

Psoriasis is a chronic inflammatory skin disease. The pathogenesis is not fully known but genetic and environmental factors are known to play a role. The disorder is characterized by erythematous plaques and silver scaling and the worldwide prevalence is approximately 2 % [1]. Increased cytokine and tumor necrosis factor-α (TNF-α) activity and increased C-reactive protein levels are present in this disorder accompanied by systemic inflammation, and associated with other pathologies such as obesity, diabetes, heart disease, and stroke [2]. Although ophthalmic complications are reported in 10 % of psoriasis patients, these symptoms can easily be overlooked, and sight-threatening complications are rare. Its ophthalmic signs are usually blepharitis, conjunctivitis, punctate epithelial keratitis, dry eye, and uveitis [3].

Optical coherence tomography is a non-invasive method that can provide sectional images of the retinal layers. The choroid could only be imaged in a limited

manner previously, but can now be imaged comprehensively with the help of the recently developed technique of enhanced depth imaging optical coherence tomography (EDI-OCT). The technique has made it possible to identify the normal choroid and the changes in many pathological conditions such as degenerative myopia and age-related macular degeneration [4–7]. Choroidal thickness has also previously been evaluated in many systemic inflammatory disorders [8, 9].

Psoriasis is an immune-mediated inflammatory process that can affect the whole body, although the skin is mostly involved [10]. We are not aware of any other study on the choroidal thickness in psoriasis patients. We assumed that the choroidal thickness could be affected in psoriasis patients and thus aimed to compare the choroidal thickness in psoriasis patients and age- and gender-matched healthy volunteers.

Methods

This study was conducted at the Ahi Evran University Training and Research Hospital's Eye Clinic and Dermatology Clinic. We followed the Helsinki declaration principles and obtained approval from the local ethics committee. A total of 38 psoriasis cases and 38 age- and gender-matched controls were evaluated. A signed consent form was obtained from all subjects. The left eye was evaluated in all subjects. Patients with a spherical equivalent higher than ±2.0 D, visual acuity less than 0.8 with the Snellen chart, with a history of ocular disease, ocular surgery or trauma or any current systemic disease such as diabetes mellitus and hypertension, and those using any ocular or systemic drugs were excluded.

We included psoriasis cases that were being followed up at the dermatology clinic in the study. Disease severity was evaluated with the Psoriasis Area and Severity Index (PASI) score. The psoriasis cases were only using topical drugs without any systemic anti-inflammatory treatment. All subjects underwent a full ophthalmic examination, and a detailed history was obtained. The ophthalmic examination consisted of intraocular pressure measurement with the air puff tonometer, visual acuity measurement with the Snellen chart, anterior segment examination with slit lamp biomicroscopy, dilated fundus examination, and choroidal thickness measurement with EDI-OCT.

OCT scan protocol

We used a previously described method for EDI-OCT [11]. The EDI mode of a spectral domain OCT (software version 6.3.3.0, Heidelberg Engineering Inc., Heidelberg, Germany) was used. The device contained a superluminescent diode with a wavelength of 870 nm and could obtain 40.000 A-scans per second. The axial and transverse resolutions were 7 and 14 μm, respectively. Two high-quality horizontal line scans were obtained through the fovea using a 1 × 30-degree area. We averaged 100 scans for each section. The automatic real-time averaging mode that maximizes the signal-to-noise ratio was used to ensure high-quality images. The choroidal thickness was measured between the outer reflective retinal pigment epithelium (RPE) layer and the inner sclera border. The choroidal thickness was measured manually by the same ophthalmologist (RK) in all subjects (Fig. 1). The sections were measured horizontally at the subfovea and across the fovea at 500-μm intervals. The digital caliper tool provided by the Heidelberg Spectralis software was used for horizontal measurement on choroidal thickness images. The points of measurement were 1.5 mm temporal and nasal to the fovea.

Statistical analysis

The SPSS 20.0 software was used for data analysis. The Kolmogorov–Smirnov test was used to evaluate consistency of the data with a normal distribution. Data evaluation was done with the χ^2 test, independent t test, and Pearson and Spearman correlation test. P values smaller than 0.05 were accepted as statistically significant.

Results

A total of 38 eyes of 38 psoriasis patients—21 females and 17 males—and 38 eyes of 38 control subjects—20 females and 18 males—were evaluated. There was no significant difference between the patient and control groups in terms of age, gender, intraocular pressure, and spherical equivalent ($P = 0.872$, 0.818, 0.406, and 0.652, respectively, Table 1). The vision was perfect in all subjects. The mean PASI score was 5.08 ± 3.94. The median disease duration was 2.5

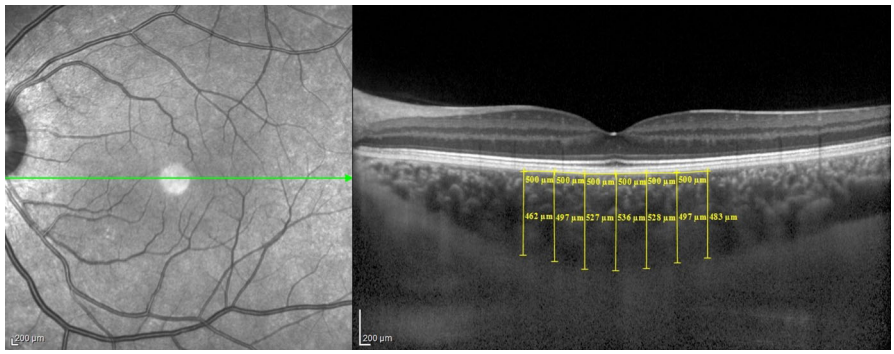

Fig. 1 Manual measurement of the choroidal thickness by a participant using EDI-OCT

(10–1) years. No significant difference was found between the patients and controls in terms of subfoveal and nasal and temporal choroidal thicknesses (Table 2). A positive correlation was present between the duration of disease and choroidal thickness at certain measurement points, but there was no significant correlation between the PASI score and choroidal thickness (Table 3).

Table 2 Choroidal thicknesses in the psoriasis patients and control subjects

	Psoriasis ($n = 38$)	Control ($n = 38$)	P
CT_{n1500}	325.7 ± 69.9	308.8 ± 87.4	0.356
CT_{n1000}	362.8 ± 78.2	339.4 ± 92.8	0.238
CT_{n500}	392.7 ± 82.8	361.2 ± 95	0.128
Subfoveal CT	408.4 ± 90.4	375.2 ± 92.7	0.117
CT_{t500}	391 ± 97.3	362.1 ± 89.7	0.182
CT_{t1000}	368.2 ± 98	345.9 ± 91.3	0.310
CT_{t1500}	351.4 ± 100.2	333.7 ± 84	0.405

CT_{n1500} choroidal thickness at 1500 µ nasal to the fovea, *CT_{n1000}* choroidal thickness at 1000 µ nasal to the fovea, *CT_{n500}* choroidal thickness at 500 µ nasal to the fovea, *Subfoveal CT* choroidal thickness at the fovea, *CT_{t500}* choroidal thickness at 500 µ temporal to the fovea, *CT_{t1000}* choroidal thickness at 1000 µ temporal to the fovea, *CT_{t1500}* choroidal thickness at 1500 µ temporal to the fovea

Discussion

The choroid is one of the most vascularized tissues and the majority of blood coming to the eye flows into this layer. The autoregulation mechanism of the choroid is not clear although several theories are present. It is vital for the blood supply of the outer retina and RPE, and it is the only source of oxygen and metabolic exchange for the avascular fovea [12]. Therefore, abnormalities in the choroid can cause RPE and photoreceptor function disorders. Indocyanine green angiography has been used to visualize the choroid for many years, and in vivo imaging is also now possible with EDI-OCT [11]. This will contribute to the understanding of normal and pathologic conditions in the choroid. Several diseases such as age-related macular degeneration, polypoidal choroidal vasculopathy, and Vogt–Koyanagi–Harada's disease originate from the choroid and their relationship with choroidal thickness has been investigated in many studies [6, 13, 14]. Choroidal thickness changes have also been monitored following treatments such as central serous chorioretinopathy treatment [15]. Systemic diseases such as hypertension and diabetes mellitus affect the vascular structure and have also been shown to affect the choroid [16, 17].

Table 1 Demographic and clinical features of psoriasis patients and control subjects

	Psoriasis ($n = 38$)	Control ($n = 38$)	P
Age (mean ± ss)	38.2 ± 11.2	38.6 ± 10	0.872
Sex (n = female/male)	21/17	20/18	818 $\chi^2 = 0.053$
Intra ocular pressure (mean ± ss)	16 ± 2.7	15.4 ± 2.6	0.406
spherical equivalent (mean ± ss)	−0.16 ± 0.61	−0.09 ± 0.67	0.652

Table 3 Correlation between the duration of the disease, PASI score, and choroidal thickness

	CT_{n1500}	CT_{n1000}	CT_{n500}	Subfoveal CT	CT_{t500}	CT_{t1000}	CT_{t1500}
PASI	$r = -0.004$	$r = 0.172$	$r = 0.144$	$r = 0.040$	$r = 0.066$	$r = 0.041$	$r = -0.012$
	$P = 0.980$	$P = 0.322$	$P = 0.409$	$P = 0.821$	$P = 0.707$	$P = 0.813$	$P = 0.944$
Duration of psoriasis	$r = 0.297$	$r = 0.326$	$r = 0.374$	$r = 0.268$	$r = 0.315$	$r = 0.322$	$r = 0.224$
	$P = 0.070$	$P = 0.046$	$P = 0.021$	$P = 0.104$	$P = 0.054$	$P = 0.049$	$P = 0.177$

CT_{n1500} choroidal thickness at 1500 μ nasal to the fovea, *CT_{n1000}* choroidal thickness at 1000 μ nasal to the fovea, *CT_{n500}* choroidal thickness at 500 μ nasal to the fovea, *Subfoveal CT* choroidal thickness at the fovea, *CT_{t500}* choroidal thickness at 500 μ temporal to the fovea, *CT_{t1000}* choroidal thickness at 1000 μ temporal to the fovea, *CT_{t1500}* choroidal thickness at 1500 μ temporal to the fovea, *PASI* psoriasis area and severity index

Kola et al. [18] found the choroidal thickness in ankylosing spondylitis cases to be significantly thicker than that in the control group when investigating this parameter in other disorders that cause systemic inflammation. They stated that the reason could be inflammation. Onal et al. [19] investigated the choroidal thickness in inflammatory bowel disorder patients and found no significant difference with the control group. Some inflammatory disorders such as Vogt–Koyanagi–Harada's disease and Behçet's disease usually affect the choroid. An increase in choroidal thickness was reported in the acute phases of these disorders, while a decrease in thickness was observed with systemic anti-inflammatory treatment [20, 21].

Psoriasis is a disorder where T cells and dendritic cells are involved in the pathogenesis. Increased keratinocyte proliferation and epidermal cell turnover result in epidermal thickening [22]. Many factors such as trauma, infections, and medications can initiate psoriasis lesions by triggering a cutaneous response. Myeloid dendritic cells activate T cells and especially Th1, Th17, and Th22 cells with the IL-23 and IL-12 cytokines they secrete. Active T cells produce psoriatic cytokines such as IL-17, IFN-γ, TNF-α, and IL-22. These cytokines cause keratinocyte proliferation and mRNA upregulation in keratinocytes, leading to the production of many inflammatory products. Induced keratinocyte products create feedback by affecting the dendritic cells and T cells, and a chronic inflammatory process eventually develops [23]. The systemic inflammatory process in psoriasis has been reported to affect the eyelids, conjunctiva, cornea, lacrimal gland, and uvea. Conjunctivitis is the most common problem. Uveitis is an ocular disorder that can cause serious complications and is usually associated with psoriatic arthritis [3]. Rishi et al. [24] reported higher ocular perfusion pressure and increased choroidal thickness in both the affected and unaffected eyes in polypoidal choroidal vasculopathy patients. The high ocular perfusion pressure in this study could be related to the increased ocular blood flow and choroidal thickness. Akkurt et al. [25] have reported that the ophthalmic, posterior ciliary, and central retinal artery blood flow in psoriasis patients is significantly higher than that in the control group. We believe that the presence of systemic inflammation in psoriasis patients could have caused the increased choroidal thickness and also that the increased ocular blood flow reported by Akkurt et al. [25] could be related to the thicker choroid values at the beginning of this study. We found that the choroid in psoriasis patients was thicker than that in the controls, but this difference was not statistically significant. However, a positive correlation was present between the duration of the disease and choroidal thickness. Türkcü et al. [26] have reported a statistically significantly thicker choroid in psoriasis cases in a new study. The mean disease duration of their patients was 15 years. The median disease duration was 2.5 years in our study, but it was about 15 years in the Akkurt et al.'s [25] study as in the Türkcü et al.'s study [26]. This suggests that the chronic systemic inflammatory process could cause clinical changes after many years. We mostly evaluated cases with a lower PASI score in this study as cases that received systemic anti-inflammatory treatment were excluded to avoid systemic inflammation suppression. However, no correlation was found between the PASI score and choroidal thickness, as in the Türkcü et al.'s [26] study. Kilic et al. have also reported no relationship between the PASI score and ocular complications [27].

In conclusion, we did not find a significant difference between psoriasis patients and healthy controls in terms of choroidal thickness. There was also no significant correlation between disease severity and choroidal thickness, but we found a positive correlation between disease duration and choroidal thickness. We believe that our results should be confirmed with larger case series on patients with longer disease duration.

Compliance with ethical standards

Conflict of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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