Choroidal Vascularity Index in Patients with Chronic Central Serous Chorioretinopathy

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ABSTRACT

Purpose: To evaluate choroidal vascular structure and choroidal thickness in patients with chronic central serous chorioretinopathy.

Materials and Methods: Thirty-four eyes of 34 patients with unilateral chronic central serous chorioretinopathy (Group 1; involved eyes, Group 2; fellow eyes) and 28 right eyes of 28 age and gender matched subjects (Group 3) were included to study. All participants underwent a detailed ophthalmic examination and an optical coherence tomography obtained by enhanced dept imaging mode (EDI-OCT). Choroidal thickness, total choroidal area, luminal area, stromal area and choroidal vascularity index were calculated with Image J program.

Results: The mean choroidal thickness was 411.47±120.16 (228-674) in Group 1 376.64±73.345 (213-578) in Group 2 and 289.93±47.495 (220-372) in Group 3. Choroidal thickness was significantly higher in Group 1 and 2 than Group 3, but it was statistically similar between Group1 and 2. The mean total choroidal area was 1.66±0.48 (0.58-2.51) in Group 1, 1.60±0.54 (0.63-2.68) in Group 2 and 1.39±0.26 (0.99-1.94) in Group 3. Total choroidal area, luminal area and choroidal vascularity index were significantly higher in Group 1 and Group 2. Choroidal vascularity indexes were 0.55±0.26 (0.18-0.64), 0.34±0.06 (0.17-0.42), 0.28±0.04 (0.20-0.35) in Group 1, 2 and 3, respectively. It was significantly higher in Group 1 and 2 than Group 3.

Conclusion: Choroidal thickness was increased in patients with central serous chorioretinopathy and their fellow eyes. Also, choroidal vascular structural changes may occur in both eyes of patients.

Keywords: Air, diabetic retinopathy, pars plana vitrectomy, perfluoropropane, silicone oil.

INTRODUCTION

Central serous chorioretinopathy (CSC) is defined as serous elevation of neurosensorial retina which typically presented with visual acuity disturbances such as decreased or distorted vision, metamorphopsia and micropsia.[1,2]

The pathogenesis of the CSC is still unclear but in recent reports suggested hypothesis is increased choroidal vascular hyperpermeability and hydrostatic pressure which lead to retinal pigment epithelium (RPE) disintegrity. The discontinuity of the RPE causes fluid leakage from choroid toward the neurosensorial retina and eventually subretinal fluid accumulation occurs.[1,3,4] The disease may be acute or chronic form, the chronicity of the disease is dependent on the duration of signs and symptoms. In general, patients who diagnosed with CSC longer than 6 months accepted as chronic CSC. Also, some authors suggested 3 months of symptoms presentation for chronic form. In chronic CSC, severe RPE changes, permanently decreased visual acuity may be seen and choroidal neovascular membrane formation may occur.[5-7]

Choroid is anatomically consisted of vascular layers called choriocapillaris, Haller layer and Sattler layer and interstitial tissue. Evaluation of all choroidal layers were not possible by current imaging techniques.[8-10] Sonoda et al[11] defined a way to determine luminal and interstitial areas of the choroid by using Enhanced Depth Optical Coherence Tomography (EDI OCT) scans. Afterwards Agrawal et al[12]

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suggested choroidal vascularity index (CVI) as a tool for following up choroidal vascularity changes.

The present study aimed to evaluate choroidal thickness, choroidal vascular changes and CVI in patients with chronic CSC.

MATERIALSS AND METHODS

The study was conducted at Ege University School of Medicine Department of Ophthalmology which is a tertiary referral hospital. The local ethic committee of Ege University School of Medicine was approved the study and an informed consent was obtained from all individual participants included in the study. The patients with chronic CSC were included the study between January 2016-December 2017. The study was carried out in accordance with Declaration of Helsinki.

A total of 34 patients with chronic CSC which symptom duration was longer than 6 months, unilateral disease and history of any treatment including laser, photodynamic therapy and anti-VEGF. The diagnosis of the disease was based on clinical examination, fluorescein angiography and OCT. Patients with CNV, high hypermetropia (<+4 diopter) or myopia (>-6 diopter), media opacities which leads to decreased image quality, and history of any intraocular surgery or steroid treatment excluded from the study. *Also, patients with systemic and ocular pathology which effect choroidal structure including diabetes mellitus, glaucoma, age related macular degeneration were excluded.(Figure 1)*

The patients and healthy controls were divided into 3 groups; the eyes with chronic CSC were Group 1, fellow eyes of these patients were Group 2 and 28 right eyes of 28 age and gender matched healthy subjects were assigned as Group 3. All participants underwent a complete ophthalmic examination including best corrected visual acuity (BCVA), intraocular pressure (IOP) measurement, anterior segment examination with slit lamp and dilated posterior segment examination with the help of 90 D lens.

Optical Coherence Tomography scans were obtained by spectralis OCT in dilated pupil. All scans were performed in EDI mode which effectively demonstrate sclera-choroid interface and provide a better evaluation of the choroid. Choroidal thickness was measured at the subfoveal region by the calipers of the device which was the distance between the outer border of the RPE and chorioscleral interface. Additionally, central macular thickness was obtained from the thickness map of the macula. After obtaining an image of EDI OCT which is passing from the fovea, total choroidal area (TCA), luminal area (LA) and CVI were calculated using image J *(National Institutes of Health, Bethesda, USA)* program as described before in detail.

Total choroidal area, stromal area, luminal area was calculated by using an open access software, Image J by one of the authors who blinded patients' groups. The method of the calculation was defined by Sonoda et al.[11] previously. A 1500 µm area was selected which was 750 µm nasal, 750 µm temporal to fovea, and the choroidal area detected vertically from RPE to chorioscleral junction and the border set with Image J ROI manager. Three choroidal vessels with lumen >100 µm were selected and average reflectivity of these were detected to obtain the average brightness. After that, the images were converted to 8 bits and adjusted by Niblack Auto Local Threshold. The images were converted red, blue and green images, then total choroidal area and luminal area was calculated.(Figure 2)

Data analysis was performed using SPSS v.20 (IBM, Armonk, NY, USA). The normal distribution of variables was evaluated by Shapiro Wilk test. Intergroup comparisons were determined by student t test and a post hoc Bonferroni test was applied when appropriate. Chi square test was used to compare categorical variables. All p values less than 0.05 were considered statistically significant.

RESULTS

A total of 34 eyes of 34 chronic CSC patients underwent PDT were included the study. All patients had symptoms more than 6 months and all measurements obtained prior to PDT treatment. The mean age of patients with CSC was 47.32±8.07 (33-63) and 44.21±6.69 in healthy participants. The difference was not statistically significant. (p=0.231). The mean BCVA were 0.49±0.26 (0.05-1.00) in Group 1, 0.94±0.15 (0.80-1.00) in Group 2 and 1.00 in Group 3. *It was converted to logMAR for statistical analysis.* It was lower in Group 1 as expected (p<0.01). *The difference was statistically significant.* There was *not* statistically significant difference in terms of IOP and gender (p values 0,433, and 0,248 respectively). (Table 1)

The involved eye of the patients with CSC had thicker central foveal thickness *and choroidal thickness than healthy participants. They were statistically significant (p values 0.007 and <0.001, respectively*). *TCA and the proportion of LA to TCA (CVI) which obtained from Image J program were higher than normal controls (p values 0.048, 0.031 respectively).* (Table 2)

The fellow eyes of patients were compared to both Group 1 and Group 3. Central macular thickness was *statistically* similar to Group 3 (p=0.482) and lower than Group 1 (p=0.03). Though SFCT was significantly higher than Group 3 *(p<0.01).* The difference between Group 1 and Group 2 was not *statistically* significant in terms of SFCT(p=0.630). Additionally, TCA, LA and CVI in Group 2 were statistically similar to Group 1 (p values 0.612 0.217,

Table 1. *Age, Gender, BCVA and Intraocular pressure values of groups.*

	Group 1	Group 2	Group 3
Age	47.32±8.07 (33-63)	47.15±8.13 (33-63)	44.21±6.69 (32-53)
Gender (Male/Female)	21/13	21/13	22/6
BCVA	0.49±0.26 (0.05-1.00)	0.94±0.15 (0.80-1.00)	1.00 (1.00-1.00)
Intraocular Pressure	15.50±2.05 (12-21)	15.00±2.20 (11-21)	15.79±3.79 (10-23)

BCVA: Best corrected visual acuity.

Table 2. *Retinal and choroidal structural characteristics.*

	Group 1	Group 2	Group 3
Central Macular Thickness	296.97±77.3 (178-536)	262.85±36.26 (175-292)	265.29±15.23 (233-289)
Choroidal Thickness	411.47±120.16 (228-674)	376.64±73.345 (213-578)	289.93±47.495 (220-372)
Totak Choroidal Area	1.66±0.48 (0.58-2.51)	1.60±0.54 (0.63-2.68)	1.39±0.26 (0.99-1.94)
Luminal Area	1.12±0.34 (0.21-1.65)	1.05±0.35 (0.39-1.67)	0.99±0.18 (0.67-1.39)
Stromal Area	0.54±0.22 (0.28-1.07)	0.55±0.24 (0.24-1.01)	0.40±0.11 (0.24-0.68)
Choroidal Vascularity Index	0.55±0.26 (0.18-0.64)	0.34±0.06 (0.17-0.42)	0.28±0.04 (0.20-0.35)

0.078, respectively), but they were *significantly* higher than Group 3. *The difference was statistically significant* (*p values 0.027, 0.041, 0.037, respectively*). (Table 2)

DISCUSSION

Central serous chorioretinopathy affects neurosensorial retina and choroid. In chronic CSC, RPE alterations are severe and persistent. Choroidal vascular changes have not been well investigated until recently. With development in OCT and EDI OCT technology choroidal changes are well understood.[6,13,14,15] Also, Sonoda et al.[11] defined a new tool for detecting choroidal vascular dilatation using Image J program helped to learn more about choroidal vascular structures. In acute CSC the changes in choroidal vasculature were defined in different reports. Despite small sample size, the current study revealed that choroidal vascular changes were significantly higher in chronic CSC patients and their fellow eyes. Also, the mean choroidal thickness was increased in patients with CSC.

In the present study, TCA, LA and CVI were significantly higher in patients with chronic CSC and their fellow eyes. Agrawal et al.[12] was investigated CVI in patients with acute CSC and resolved CSC. They present increased CVI and LA in eyes with acute CSC. Also, the difference was significantly higher than their fellow eyes. Additionally, Rasheed et al.[16] showed increased CVI compared to their fellow eyes and healthy participants. After treatment, the patients who underwent laser treatment showed a mild decrease in CVI when compared to patients without treatment. But all patients in the study had acute CSC without any RPE alterations. In a current report, Demirel et al.[17] investigated choroidal vascular and structural changes in patients with chronic CSC who underwent PDT treatment and they found that TCA and LA were significantly decreased after PDT treatment. In the current study, choroidal vascular changes including TCA, LA and SA were similar between in eyes with chronic CSC and their fellow eyes. This may be related to disease chronicity and functional decrease in RPE.

Choroidal thickness is increased in patients with CSC and it usually decreases after the treatment. Jirarattanasopa et al[18] assessed macular choroidal thickness in CSC patients and showed increased choroidal thickness in the total macular area. They attributed to leakage from RPE, increased choroidal hydrostatic pressure and hyperpermeability. Chung et al[19] reported that subfoveal choroidal thickness was significantly decreased after resolving of the disease. But they found that the thickness was decreased in Haller layer. Choriocapillaris/Sattler' s layer was similar between active and resolved state. In the present study, choroidal thickness was significantly higher in eyes with CSC compared to healthy subjects, but it was similar to fellow eyes of the patients. This may refer to that the disease is bilateral.

Pachychoroid spectrum diseases have been described recently. The common features of the spectrum including increased choroidal thickness, choroidal hyperpermeability, thinning or absence of choriocapillaris and Satler' s layer. CSC is defined in the pachychoroid diseases spectrum which are characterizes with choroidal thickening and RPE abnormalities. The symptoms in CSC usually seen unilaterally but choroidal thickening occurs bilaterally. Also, choroidal thickness regresses with PDT treatment and recurrences of the disease decrease.[20-23] The current report showed bilateral increased choroidal thickness and RPE changes which is properties of that spectrum.

In conclusion, there is a serious relationship between choroidal vascular structures and development of central serous chorioretinopathy, but it is controversial which is the reason and the result. According to the results of this study, bilateral vascular pathologies and development of central serous chorioretinopathy after a certain threshold suggest that choroidal vascular pathologies already exist and central serous chorioretinopathy develops secondary to these pathologies. Also, the fellow eyes of patients have increased choroidal thickness which refers disease bilaterality.

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