Saudi Journal of Ophthalmology (2016) 30, 88–91

Original Article

Imaging drusens using Spectral Domain Optical Coherence Tomography

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Abstract

Purpose: The purpose was to evaluate pathological changes of photoreceptor layer and retinal pigment epithelium in eyes with drusens using Spectral Domain Optical Coherence Tomography (SD-OCT).
Methods: Twenty-nine eyes of 29 patients with (drusens) dry age-related macular degeneration and 43 eyes of 43 controls were included in this study. All subjects underwent complete ophthalmic examination including SD-OCT. Central foveal thickness (CFT), photoreceptor layer (PRL) thickness and retinal pigment epithelial (RPE) thickness were measured and compared between the groups. *P* value < 0.05 was considered statistically significant.
Results: Best corrected visual acuity (BCVA) ranged between 20/20 and 20/200. RPE (36.10 ± 5.48 μm Vs 39.27 ± 4.30) and PRL thickness (53.93 ± 7.36 μm Vs 61.20 ± 4.50 μm) were significantly reduced in patients with drusens compared to controls. Increase in age was a significant risk factor for drusens (OR: 1.22, $p < 0.001$) and increased PRL thickness was a protective factor (OR: 0.720, $p = 0.002$). PRL thickness was significantly associated with BCVA ($p = 0.019$).
Conclusion: With an increased resolution of SD-OCT, the involvement of the outer retinal layers was more clearly defined. SD-OCT may allow for the early detection of exudative changes.

Keywords: Age related macular degeneration, Spectral Domain Optical Coherence Tomography, Photoreceptor layer, Retinal pigment epithelium

http://dx.doi.org/10.1016/j.sjopt.2015.11.004

Introduction

Age-related macular degeneration (AMD) is the leading cause of irreversible blindness in industrialized countries. Drusen is the earliest visible abnormality in AMD. Drusens are regarded histopathologically as deposits of extra cellular material lying between the basement membrane of the retinal pigment epithelium (RPE) and the inner collagenous zone of Bruch's membrane.[1] Spectral Domain Optical Coherence Tomography (SD-OCT) has been used extensively to characterize drusen structure in AMD.[2] AMD is characterized by the progressive degeneration of photoreceptors, RPE, and choroiod.[3] Histopathological studies show both hyper pigmentation and hypo pigmentation of the macular RPE and abnormalities in the photoreceptors including photoreceptor cell loss.[4]

The aim of the present study was to evaluate the pathological changes of photoreceptor layer (PRL) and RPE in eyes with drusens in early AMD using SD-OCT.

Received 15 May 2014; received in revised form 2 November 2015; accepted 11 November 2015; available online 23 November 2015.

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Peer review under responsibility of Saudi Ophthalmological Society, King Saud University

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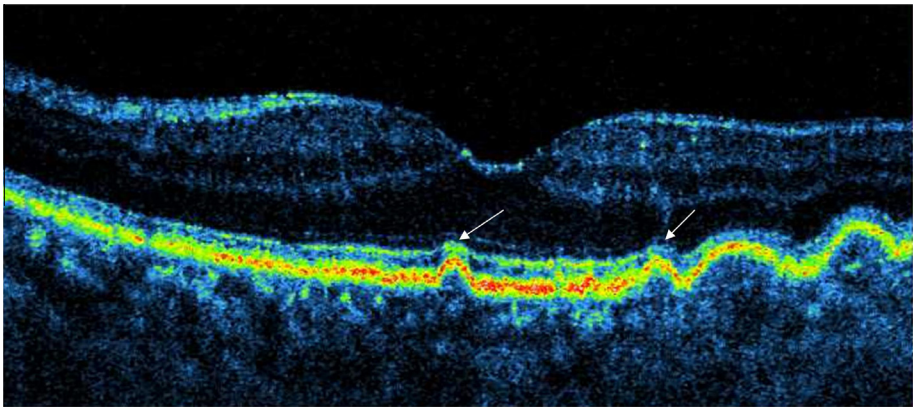

Figure 1. SD-OCT showing Drusens. Drusen appears as irregular elevations of the highly reflective RPE layer and showing the thinning of the photoreceptor layer overlying the drusen.

Materials and methods

Twenty-nine eyes of 29 patients with drusens and 43 eyes of 43 controls were included in this prospective case control study. All patients underwent a thorough clinical examination that comprised of best corrected visual acuity (BCVA) assessment which was measured using ETDRS chart, biomicroscopy of the anterior and posterior segment and indirect ophthalmoscopy. Only eyes with media sufficiently clear to allow good quality SD-OCT scans were included. Subjects with pathology other than drusen were excluded from this study. The study was approved by the organization's Institutional Review Board, and informed consent was obtained from the subjects in accordance with the Helsinki Declaration.

SD-OCT images were generated using Copernicus instrument (Optopol, Poland) with 2 mm axial depth and 4–10 mm transverse width. The resolution was about 6 μm in the axial direction and 12–18 μm in the transverse direction. Retinal structural details in cases with drusens were obtained using 7 mm scan with 6 B-scans and 2743 A-scans per B-scan in the macula, each separated by 30 degrees. Based on the reflectivity of SD-OCT cross section images, PRL, RPE and central foveal thickness (CFT) were measured manually using the callipers. CFT was measured as a distance between the vitreoretinal interface and the inner border of RPE. PRL thickness was defined as the distance between the medium reflective membrane which represents external limiting membrane and the inner border of RPE. In all the subjects, the integrity of all inner and outer retinal layers was assessed using SD-OCT.

Statistical analysis was performed using SPSS ver15.0 statistical package. Kolmogorov–Smirnov Z test was done to test the distribution of data. We found that the data were normally distributed. Independent t-test was used to compare the PRL, RPE and the foveal thickness between the groups. Pearson correlation was performed to see the correlation between the variables. Multiple logistic regression was performed to assess the risk factors for presence of drusens. Linear regression was performed to assess the association of thickness parameters with visual acuity. *P* value less than 0.05 was considered statistically significant.

Results

Mean age of the study sample was 54.87 ± 11.07 years. Men and women were equally distributed in the study. BCVA ranged from 20/20 to 20/200. The inner retinal layers were normal, whereas the outer retinal layers showed structural alterations in eyes with drusens (Fig. 1). Table 1 shows the clinical parameters among the study sample. No significant difference in CFT was found between the groups ($p = 0.535$). Mean PRL thickness was significantly reduced in patients with drusens compared to controls (53.93 ± 7.36 vs 61.2 ± 4.5 μm, $p < 0.001$). Mean RPE thickness in patients with drusens was significantly reduced (36.10 ± 5.48 vs 39.27 ± 4.30 μm, $p = 0.001$). Multiple logistic regression analysis was done to assess the risk factors for presence of dry AMD. It was found that increased age was a significant risk factor for drusens (OR: 1.22, $p < 0.001$) and increased PRL thickness was a protective factor (OR: 0.720, $p = 0.002$) when adjusted for age, gender, CFT, PRL and RPE thickness.

BCVA was significantly reduced with reduced PRL thickness ($r = -0.564$, $p = 0.002$) (Fig. 2) and CFT ($r = -0.410$, $p = 0.017$) among patients with drusens. No correlation was found between BCVA and age ($r = -0.024$, $p = 0.904$) as well as age and PRL thickness ($r = -0.119$, $p = 0.540$) in our study sample. In multivariate model including age, PRL and CFT, only PRL thickness ($p = 0.019$) had significant association with BCVA (Table 2).

Fig. 3 shows a hyper-reflective foci over the drusen (a) and reduced reflectivity of IS/OS junction around the drusen (b).

Table 1. Clinical parameters of the study sample.

Parameters	Controls	Cases	*p*
Visual acuity (log MAR)	0.00 ± 0.00	0.25 ± 0.24	<0.001
Central foveal thickness	168.41 ± 16.63	165.58 ± 21.83	0.535
Photoreceptor layer thickness	61.20 ± 4.50	53.93 ± 7.36	<0.001
Retinal pigment epithelium thickness	39.27 ± 4.30	36.10 ± 5.48	0.008