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Vascular Length Density and Vessel Density in the Foveal Avascular Zone Dysplasia -Imaging of the Foveal Avascular Zone Dysplasia

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Abstract

Aim: To report the vascular length density and vessel density anomalies in foveal avascular zone dysplasia.

Methods: A case of foveal avascular zone dysplasia was observed by color fundus photography, fundus autofluorescence, vessel density, vascular length density and swept source optical coherence tomography (SS-OCT), etc.

Results: The macula of both eyes exhibited the incomplete or absent foveal avascular zone. The color fundus photography revealed a diminishment in the foveal light reflex, the fundus autofluorescence findings were within normal limits, both eyes exhibited a band-like high reflection on the temporal side of the fovea in both eyes by SS-OCT. The central foveal thickness and the subfoveal choroidal thickness of foveal avascular zone dysplasia increased. In the central area (1 mm circle) of the macula, the vessel density of the superficial capillary plexus was determined to be 19% in the right eye and 43% in the left eye, whereas in the deep capillary plexus, it was observed to be 25% in the right eye and 40% in the left eye. The vascular length density was measured at 11.2/mm in the right eye and 27.1/mm in the left eye.

Conclusion: The central foveal thickness and subfoveal choroidal thickness exhibited an increase in cases of foveal avascular zone dysplasia. The vascular length density and vessel density are valuable evaluation indexes.

Keywords: Foveal Avascular Zone Dysplasia; Foveal Avascular Zone; Vascular Length Density; Vessel Density; Swept Source Optical Coherence Tomography

Abbreviations: FAZ: Foveal Avascular Zone; VLD: Vascular Length Density; VD: Vessel Density; SS-OCT: Swept Source Optical Coherence Tomography; BCVA: Best Corrected Visual Acuity; CFP: Color Fundus Photography; CFT: Central Foveal Thickness; SFCT: Sub Foveal Choroidal Thickness; OCTA: Optical Coherence Tomography Angiography; SCP: Superficial Capillary Plexus; DCP: Deep Capillary Plexus

Introduction

The foveal avascular zone dysplasia is a rare condition characterized by the presence of capillaries enveloping the macula resulting in the absence of the foveal avascular zone (FAZ). This anomaly can manifest through various alterations observed in imaging techniques. The vascular length density (VLD) is different from the vessel density (VD). VLD is a special algorithm and a special imaging process on the swept source optical coherence tomography (SS-OCT) which is mainly present in the superficial capillary plexus. This report describes the imaging characteristics of VLD and VD of the foveal avascular zone dysplasia.

Case Reports

In the multi - mode images, different image characteristics of foveal avascular zone dysplasia are presented. A 23-year-old female patient complained of eye fatigue for one week. The best corrected visual acuity (BCVA) was 1.0 (decimal) in both eyes, and the intraocular pressure was measured as 17 mmHg in the right eye and 18 mmHg in the left eye. The slit lamp microscope examination revealed unremarkable anterior segments of both eyes. The patients' medical and family histories were unremarkable.

Results

The color fundus photography (CFP) revealed a diminishment in the foveal light reflex, while no additional retinal abnormalities were observed in both eyes. (Clarus 500, Carl Zeiss Meditec, Inc). The fundus autofluorescence (FAF) findings were within normal limits (Panoramic ophthal moscope, Daytona P200T). The SS-OCT examination (all OCT parameters were calculated automatically by the internal software) revealed a central foveal thickness

(CFT) of 329μm, while the subfoveal choroidal thickness (SFCT) was measured to be 323μm in the right eye. CFT was quantified as 317μm in the left eye, while SFCT measured 355μm. Both eyes exhibited a band-like high reflection on the temporal side of the fovea (SS-OCT, BM-400K, Tianjin, China) (Figure 1).

Optical coherence tomography angiography (OCTA) was utilized for macular imaging, employing 3×3 mm scans to generate en face representations of both the superficial capillary plexus (SCP) and the deep capillary plexus (DCP). The macula of both eyes exhibited the incomplete or absent foveal avascular zone. Although the macula is anatomically divided into five regions, this paper focuses solely on analyzing the 1mm diameter region located at its center. In the central area (1mm circle) of the macula, VD in the superficial capillary plexus was found to be 19% in the right eye and 43% in the left eye, while located within the deep capillary plexus, it was observed to be 25% in the right eye and 40% in the left eye (Figure 2). The VLD of both eyes was assessed using a specialized imaging technique on SS-OCT. In the central macular region (1mm circle), the VLD of the superficial capillary plexus was measured to be 11.2/mm in the right eye and 27.1/mm in the left eye, respectively (Figure 3).

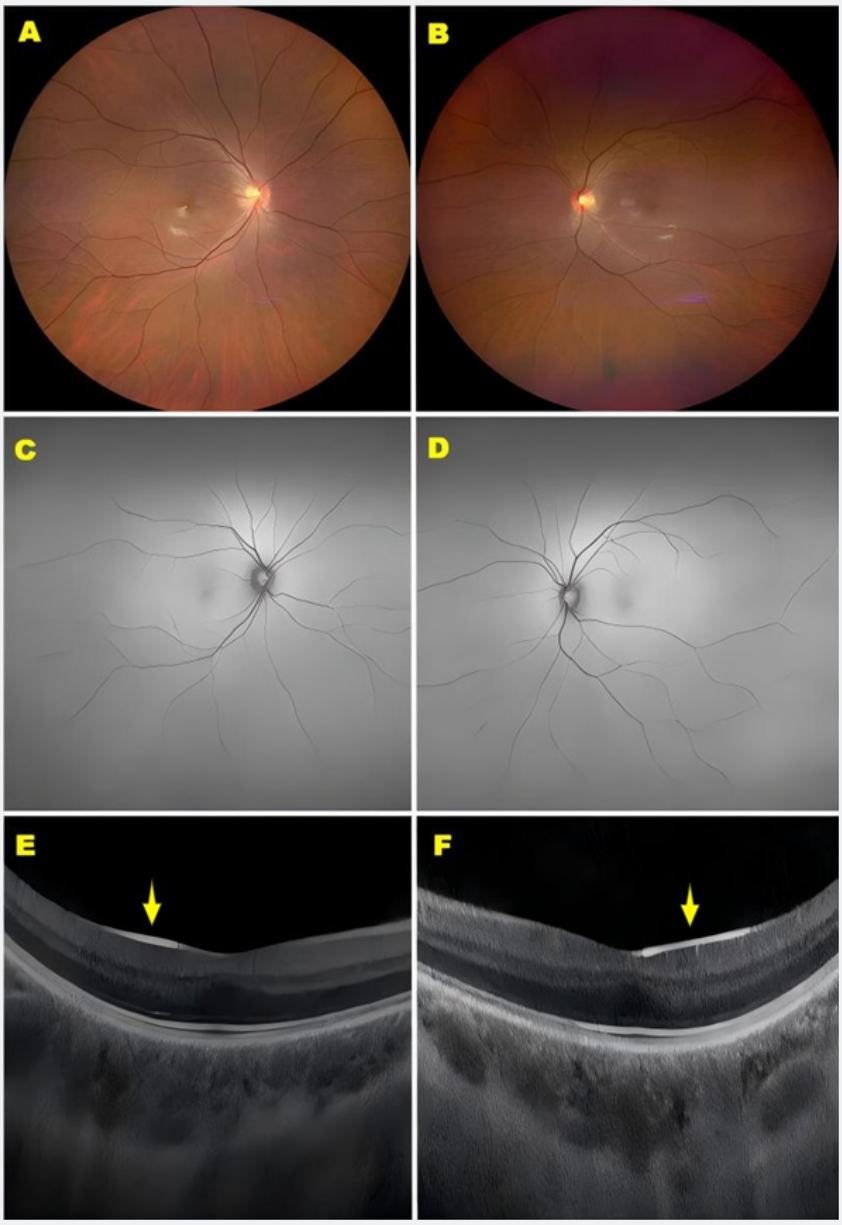

Figure 1: CFP: the right eye (A), the left eye (B). FAF: the right eye (C), the left eye (D).
The temporal side of the fovea in both eyes showed a band-like high reflection (yellow arrow), the right eye (E), the left eye (F).

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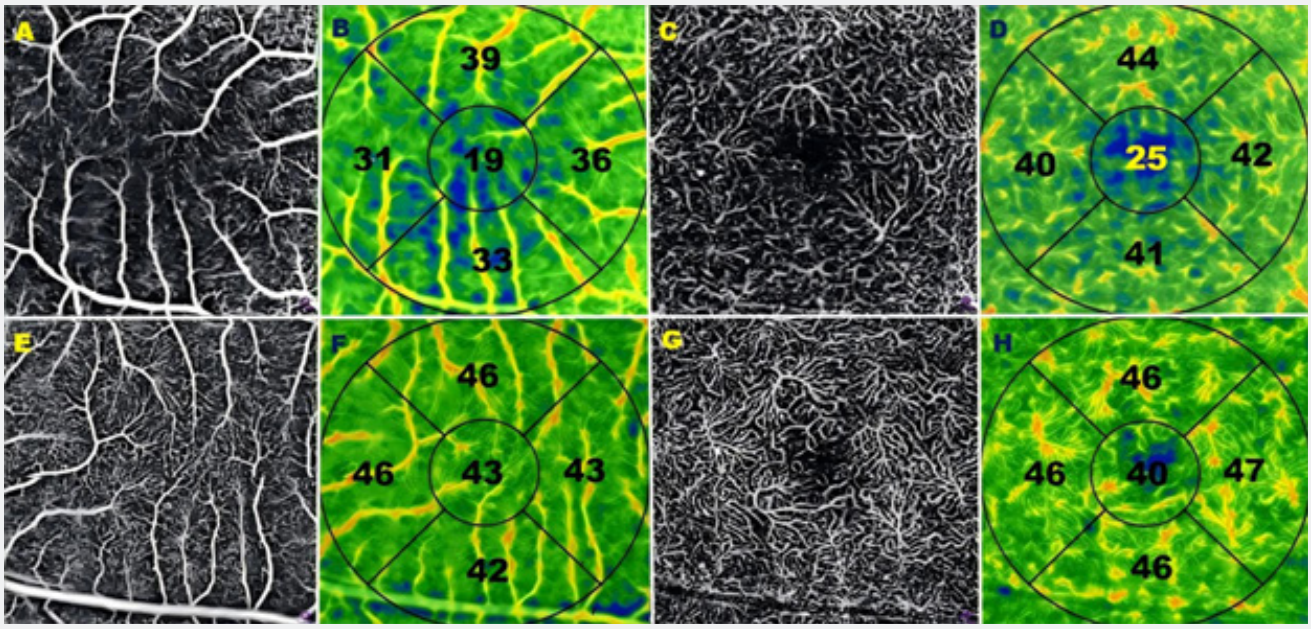

Figure 2: The macula of the right eye showing SCP (A), VD of SCP (B), DCP (C), VD of DCP (D). The macula of the left eye showing SCP (E), VD of SCP (F), DCP (G), VD of DCP (H).

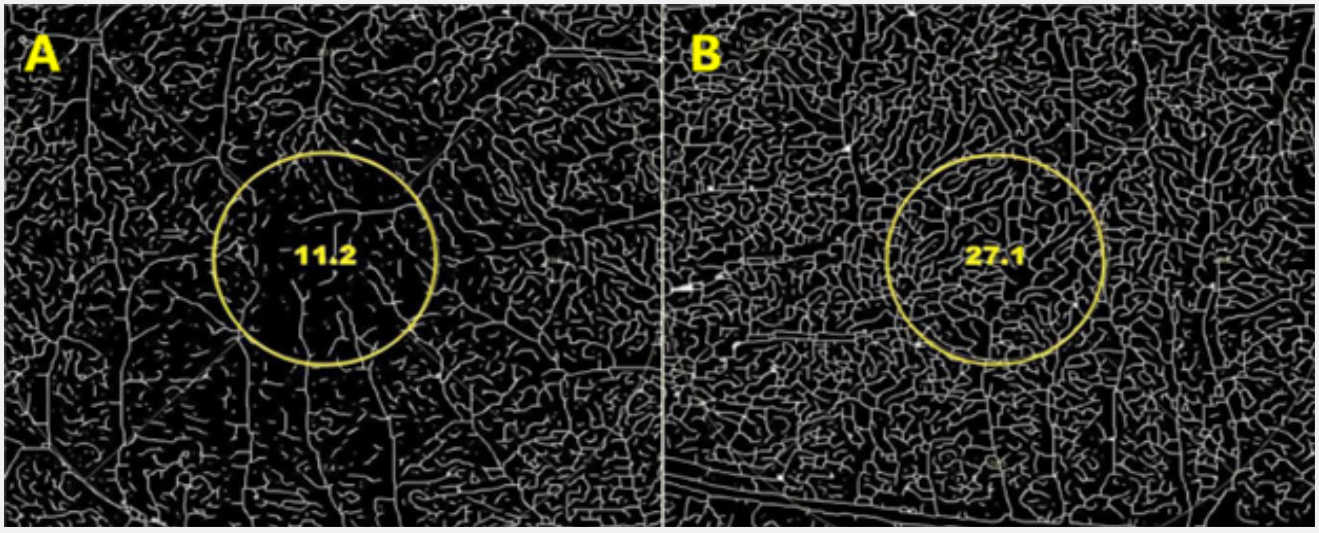

Figure 3: VLD of the right eye (A). VLD of the left eye (B).

Discussion

Foveal avascular zone dysplasia is a rare condition characterized by the presence of capillaries covering the macula which results in absence of FAZ. It can manifest in a variety of imaging changes. The foveal avascular zone is a region within the retina that lacks capillaries, and it is widely acknowledged to play a crucial role in visual acuity [1]. The macula was imaged using 3×3 mm scans on OCTA. Following the protocol of the Early Treatment of Diabetic Retinopathy Study (ETDRS), VD was quantified in a predefined set of five anatomical regions. VD was measured as the proportion of the retinal sector occupied by vessels [2]. VLD is defined as the total length of the skeletonized perfused vasculature per unit area [3]. The primary focus of this paper is the analysis of the region with a diameter of 1mm, precisely located at its central position despite the anatomical division of the macula into five regions.

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The vascular length density differs from the vessel density in that it is a distinct algorithm with a lower detection value compared to the vessel density, primarily present in the SCP. It provides clear visualization of abnormal vascular distribution and enables quantitative analysis of the macula. In the case of foveal avascular zone dysplasia, interocular variability in vessel length density may arise from differences in capillary coverage over the central fovea between the two eyes. VLD measure may exhibit greater sensitivity to alterations in capillaries and small blood vessels compared to VD, thereby potentially emerging as an early disease biomarker. An observation also confirmed that VLD demonstrated to be early microvascular changes in prediabetic patients evaluated by OCTA [4].

A characteristic feature of foveal avascular zone dysplasia is the presence of foveal capillaries, as demonstrated by OCTA imaging, accompanied by preservation of the inner retinal layers within the fovea. CFT of foveal avascular zone dysplasia tends to thicken. The mean CFT in normal eyes was 263.2 ± 22.0 μm [5]. In this study, the central foveal thickness was measured as 329μm in the right eye and 317μm in the left eye. The observed increase in CFT can be attributed to the absence of foveal avascular zone. The subfoveal choroidal thickness was defined as the vertical distance from the hyperreflective line of Bruch's membrane to the hyperreflective line of the inner scleral surface.

In recent years, SFCT has garnered significant attention in the clinical domain for its utility in decision-making pertaining to the diagnosis, management, and monitoring of diverse choroidal and retinal pathologies. A study has shown that the average SFCT was 265.3 ± 25.9μm [6]. Another observation indicates that the SFCT of normal control eyes was 277.6 ± 73.4 μm [7]. The results revealed a significantly increased subfoveal choroidal thickness in individuals with foveal avascular zone dysplasia compared to that observed in healthy subjects. However, this study also observed that the absence of FAZ could possess favorable BCVA outcomes.

Data Sharing Statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Ethics Statement

Written informed consent was obtained from the individual for the publication of any potentially identifiable images or data included in this article. This study adhered to the tenets of the Declaration of Helsinki. Institutional review board approval and informed consent from patients was obtained.

Disclosure

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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