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Optical Coherence Tomography Angiography (OCTA) is a non-invasive and highly detailed new technology

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Abstract:

Introduction: Compared to Fundus Fluorescein Angiography (FFA), the Optical Coherence Tomography Angiography (OCTA) provides more information about deeper retinal layers while being non-invasive and extremely detailed. OCTA is a new modern screening technology that offers fast, noninvasive and high-resolution imaging of retinal and choroidal vascular layers and blood flow without using systemic dye injection internally.

Aim of the study: To describe detailed imaging of (OCTA) over (FFA) among the eyes of the healthy Caucasian population.

Subjects and Methods: This retrograde descriptive study included participants with normal eyes. A full ophthalmic examination was done. Using (OCTA), the macula was scanned.

Results: 200 normal eyes from 100 participants made up the study's total sample size. At superficial and deep capillary retinal plexus (SCP and DCP), the mean visual density (VD) of the perifoveal area was $51 \pm 2.5\%$ and $51 \pm 5.3\%$, respectively. The average diameter of the foveal avascular zone (FAZ) was $0.29 \pm 0.11 \text{ mm}^2$.

Conclusions: (OCTA) provides images that are more detailed than FFA. (OCTA) is a beneficial imaging tool for assessing and measuring the vascularity of the deep and superficial capillary plexus. The median change in the (FAZ) volume in retinal vascular disorders will be influenced by normative data.

Keywords: FFA; DCP; FAZ; OCT; SCP; VD.

1. Introduction

The Optical Coherence Tomography Angiography (OCTA) is a helpful imaging instrument for measuring and assessing the vascularity of the deep and superficial

capillary plexus. The median change in the foveal avascular zone (FAZ) volume in retinal vascular disorders will be influenced by normative data [1–3].

A significant benefit of OCTA over FFA is its capacity to separate superficial and deep capillary retinal plexus (SCP and DCP) and evaluate the different vascular layers of the retina independently [4].

Previously, Fundus Fluorescein Angiography (FFA) was used to visualize the retinal capillary plexus (RCP) structure, but as FFA can only give images of overall vascularization, we were unable to distinguish the specifics of particular vascular layers. However, a non-invasive, very accurate technique called OCTA enables us to reconstruct images of the macular and peripapillary vascular system with a level of clarity and detail that has never previously been attained [5].

Both FFA and Indocyanine Green Angiography (ICGA) are invasive procedures that call for intravenous dye delivery and imaging for 10 to 30 minutes [6,7]. They offer two-dimensional images which enable dynamic flow of blood visualization with a large field of imaging. So, it is possible to recognize and understand patterns of dye pooling, staining and leakage [8]. FFA continues to be the superior quality for the detection of choroidal neovascularization (CNV), and neovascularization of the retina such as disc neovascularization (NVD) and

neovascularization elsewhere (NVE) [9,10]. whilst, cataracts and also hemorrhage or media opacities, can obscure retinal pathology, and determination of the deep extension of the disease and the amount of delineation of new vascular formation can be not clear due to dye seepage and poor stereopsis, as well as because imaging techniques are not depth illustrated. For that, segmenting various retinal levels with FFA or ICGA is not frequently achievable. Because of that, locating the axial position of pathology entails a perception of obstruction and leakage manners [8]. To distinguish between CNV type 1, which is located in between the RPE and choriocapillaris, and CNV type 2, which is located in between the retina and RPE, it is necessary to realize that the RPE hides the beneath fluorescence, thus CNV type 1 demands a much more volume of dye to the bank prior hyper fluorescence is being detectable [11].

Other disadvantages of FFA and ICGA may restrict their common spread application in that they are not suitable modalities for being utilized in a regular busy clinic as being invasive, rather than time and money consumption. Although deemed safe, the dyes can cause nausea and allergic responses, in addition to anaphylaxis

in some cases. Besides the risk of allergic responses, that is increasing with the frequency of dye usage. In addition, indocyanine green dye is not recommended during pregnancy or if you have kidney disease. A quick non-invasive procedure for examining retinal as well as choroidal arteries could be advantageous for evaluating patients who require numerous follow-up routine exams or who could not endure intravenous dye injection [12,13].

By contrast, OCTA is a non-intrusive procedure which uses dye to gather vascular volumes datum. The generation of every 3D scan set lasts roughly six seconds. Following that, the en-face photos (OCT angiograms) could be segmented to view the superficial and deep retinal parts, choriocapillaris, or any area of demand, as well as to view each

vascular plexus. Since all scanning areas use an equal amount of OCTA b-scans, the current en-face acquired regions span from 2 x 2 mm to 12 x 12 mm, with imaging quality significantly reducing with a broader field of view. The 12 x 12 mm scan size is limited to study prototypes. Matsunaga et al. found that the 3 x 3 mm OCT angiograms and the current FA/ICGA pictures exhibit comparable levels of critical vascular information, despite the latter appearing to have a better resolution [14]. Similar to FA/ICGA, the montage technique preserves the improved resolution while allowing for a wider field of view (**Figure 1**). Motion tracking is used by Carl-Zeiss, Inc. (Carl-Zeiss Meditec, Dublin, CA) to follow eye movement and stitch together scans in their automatic wide-field montage software [14].

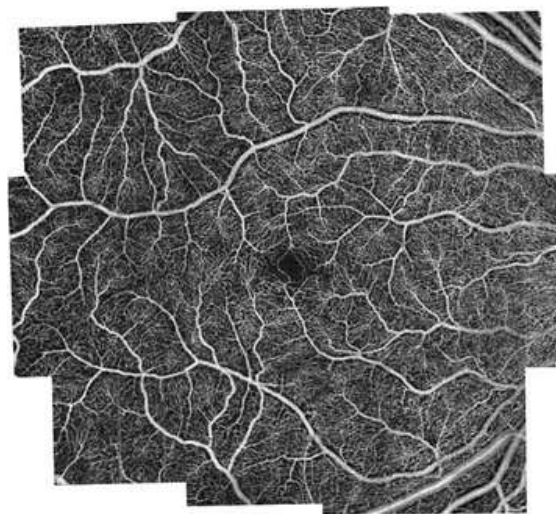


Figure 1: The montage technique.

The OCTA Large-Fielded Montage of a Normal Eye. A right normal eye from a 56-year-old Caucasian male was captured in a wide-field OCTA montage. Photos were processed in Adobe Photoshop (San Jose, CA) after being taken with the RTVue XR Avanti's Angiovue software (Optovue, Inc., Fremont, CA). Similar to fluorescein and indocyanine green angiography, this maintains great resolution while offering a larger field of view [14].

The most widely available prototype OCTA equipment is the RTVue-XR Avanti spectral-domain OCT (SD-OCT) (Optovue, Inc., Fremont, CA) with the AngioVue software, that utilizes a split-spectrum amplitude-decorrelation angiography (SSADA) approach. The instrument does volume measuring images of 304×304 A-scans at 70,000 A-scans per second in around 3.0 seconds. The program enables direct automatic splitting of those full-thickness retinal images into "superficial"

and "deep" inner retinal vascular plexuses, outer retina, and choriocapillaris (**Figure 2**). It also permits 2×2 mm, 3×3 mm, 6×6 mm, and 8×8 mm OCT angiograms (**Figure 1**). In the OCT angiography splitting of the superficial inner retina, the vasculature in the retinal nerve fibre layer (RNFL) and ganglion cell layer (GCL) is projected (Figure 2). A composite of the vascular plexuses at the boundaries of the inner plexiform layer (IPL) and inner nuclear layer (INL), as well as the INL and outer plexiform layer (OPL), is visible in the deep inner retina OCT angiography segmentation (Figure 2F). The manual division of full-thickness scans is done into three categories: the outer retina, choriocapillaris, choroidal layers, and the superficial (RNFL plexus), intermediate (GCL plexus), and deep (IPL/INL and INL/OPL edges) internal retinal vascular plexuses. Using this OCTA technique, Choi et al. described the choriocapillaris and choroidal arteries in normal eyes [15].

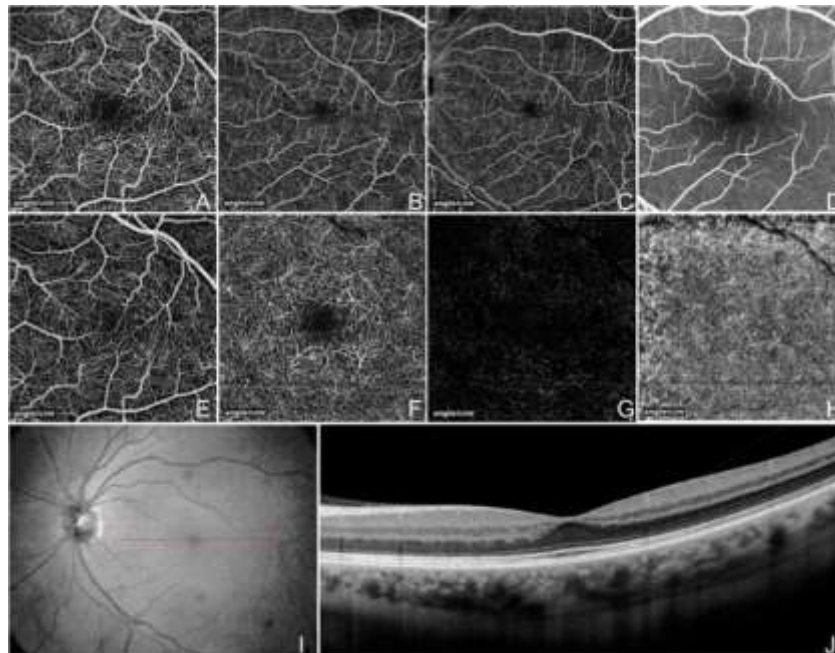


Figure 2: RTVue-XR Avanti spectral-domain OCT (SD-OCT) (Optovue, Inc., Fremont, CA). The segmentation layers and fields of view of Angiovue's OCTA. A normal left eye was examined. (A) Bruch's membrane to internal limiting membrane in 3 x 3 mm full-thickness OCT angiography. (B) An OCT angiogram measuring a complete 6 x 6 mm thickness. (C) A full-thickness OCT angiogram measuring 8 x 8 mm. In comparison to A-C, (D) fluorescein angiography clipped to 8 x 8 mm or 30 degrees displays less capillary detail. (E) 3 x 3 mm OCT angiography of the "Superficial" inner retina. (F) Three by three mm OCT angiography of the "Deep" inner retina. (G) An outer retinal 3 x 3 mm OCT angiography shows the lack of blood vasculature

Flow data is delivered by OCTA at a certain moment in time. For disorders like CNV, accurate determination and volume measuring can be done even while leakage is negligible (de Carlo TE et al., unpublished data in review) [16]. This is specifically

useful for detecting type 1 CNV, for which FA/ICGA localization may be erroneous because it is inferential. Since hemorrhage decreases light's ability to reach the outer layers of the retina, it can obstruct retinal blood flow on OCTA [2].

2. Materials and Methods

2.1. Study Design

It's a cross-sectional study with participants who have normal eyes. OCTA was utilized to scan the macular area. Fayoum Ophthalmology Hospital received 100 patients for routine examinations. The study comprised healthy people with Best Corrected Visual Acuity (BCVA) between 6/6 to 6/9. Excluding criteria included any situation that impeded clear accurate fundus imaging, candidate motions, repeated blinking, ophthalmic surgery, or laser history.

A complete ophthalmologic examination included a full personal, clinical and medical history, visual assessment, slit-lamp anterior segment

examination and hydrated pupil (1% tropicamide) fundus examination. The imaging in addition to examination were both performed at one day. Coherence in Optical Waves Images of tomography angiography were obtained using the prototype Angio Vue OCTA. A 6×6 mm OCTA was captured with fixation at the fovea.

2.2. Statistical analysis plan

Descriptive statistics are presented in the form of numbers for (FAZ) area and percentages for retinal vascular density. Mean measures are reported for numerical variables. GNM ABSS 25 for Windows software was used for the analysis.

3. Results

100 patients were included in this study. 50% are males and 50% of them are females. The mean Superficial-Peri fovea in the right eye is 51.5 ± 2.6 (%), in the left eye is 50.9 ± 2.6 (%), and in both eyes is 51.2 ± 2.1 (%). The mean Deep-Peri fovea in the

right eye is 51.8 ± 6.0 (%), in the left eye is 50.6 ± 6.8 (%), and in both eyes is 51.2 ± 5.3 (%). The mean foveal avascular zone in the right eye is 0.29 ± 0.12 mm², in the left eye, is 0.29 ± 0.12 mm², and in both eyes is 0.29 ± 0.11 mm².

Table 1: Summary of macular micro-vascular measures.

| Variables | Right eye | Left eye | Average |
|----------------------------|-----------|-----------|-----------|
| Superficial peri fovea (%) | 51.5±2.6 | 50.9±2.6 | 51.2±2.1 |
| Deep peri fovea (%) | 51.8±6 | 50.6±6.8 | 51.2±5.3 |
| FAZ (mm ²) | 0.29±0.12 | 0.29±0.12 | 0.29±0.12 |

4. Discussion

OCT-A is proving to be a more helpful method for imaging and measuring vascular anomalies in a range of retinal and choroidal vascular diseases, according to several investigations [16–17].

In Wang et al.'s investigation of volume density in the retina and choriocapillaris, as assessed by OCTA in 105 Chinese eyes, the average size of FAZ in the inner vascular network was found to be 0.35 ± 0.12 mm² [18]. After examining 34 eyes from 17 healthy individuals, Shahlaee et al. discovered that the median area of SCP FAZ was 0.27 ± 0.10 mm² [19].

Wons et al. observed that there was a comparison between the average SCP FAZ and DCP FAZ ($p < 0.05$), but no difference in FAZ diameter of the subjects' contralateral eyes for either the superficial or deep capillary plexuses [20].

The average FAZ area was measured in 17 eyes with branch retinal vein occlusion

(BRVO) and 17 eyes without any affliction by Samara et al. [21]. There was a significant difference in DCP between BRVO and healthy eyes (0.519 mm² against 0.410 mm²), however, the average superficial FAZ diameter in BRVO eyes was 0.312 mm² and 0.284 mm² in healthy eyes ($p = 0.54$). The DCP FAZ showed a significant increase in this study, but the SCP did not. Additionally, they found that, in both networks, the vascular network's volume density was lower in BRVO eyes than in other eyes.

Conclusion and recommendations

(OCTA) is a new diagnostic equipment which provides more detail and deep penetration into the inner retinal and choroidal layers. In addition to saving time, it is a non-invasive procedure that avoids the possible dangers of dye injection in fluorescein fundus angiography (FFA). We recommend that it be used more frequently than (FFA) in outpatient clinics due to its safety and lack of time commitment.

Ethical approval and informed consent: This research was agreed upon by the ethical committee at the Faculty of Medicine, Fayoum University. The patient's informed written consent has been acquired for this paper to be published.

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Conflict of Interest: There is no conflict of interest.

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