Journal of Medicine in Scientific Research

Volume 4 | Issue 3 Article 9

Subject Area: Ophthalmology

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Recommended Citation

Atia, Alaa; Samir, Ghada; and O Elrashidy, Hussam E. (2021) "The role of optical coherence tomography angiography in diagnosis of central serous chorioretinopathy," *Journal of Medicine in Scientific Research*: Vol. 4: Iss. 3, Article 9.
DOI: https://doi.org/10.4103/JMISR.JMISR_101_20

The role of optical coherence tomography angiography in diagnosis of central serous chorioretinopathy

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Abstract

Purpose

To detect the findings of optical coherence tomography angiography (OCTA) in eyes with central serous chorioretinopathy (CSCR), in comparison with conventional multimodal imaging.

Patients and methods

In the current case series, 80 eyes of 80 patients were diagnosed to have CSCR, and they underwent spectral domain optical coherence tomography (SD-OCT), fluorescein angiography (FA), and OCTA. OCTA images are performed at two main depth intervals: automatically segmented outer retina and automatically segmented choriocapillaris.

Results

In 40 of 80 eyes, OCTA images showed detached retina adjacent to the leakage point, compared with 40 of 80 eyes using FA, and 80 of 80 eyes using SD-OCT. In 44 of 80 eyes, irregular flow patterns were observed on OCTA images through the choriocapillaris. OCTA images could not identify leakage points in any of the included eyes, compared with 68 of 80 eyes on FA, and 56 of 80 eyes on SD-OCT. In 12 of 80 eyes, abnormal vessels (associated choroidal neovascularization) were observed on OCTA images, compared with eight of 80 eyes in SD-OCT and four of 80 eyes in FA.

Conclusion

OCTA images of the superficial and deep retinal plexus, outer retina, and choriocapillaris did not reveal altered flow patterns directly associated with the leakage point in acute CSCR. However, OCTA was able to visualize altered choroidal flow in some of the included eyes and was the best between all other modalities in detection of choroidal neovascularization in eyes with chronic CSCR.

Keywords: Central serrous chorioretinopathy, Optical coherence tomography angiography, Spectral domain optical coherence tomography, fundus flourescein angiography

Introduction

Central serous chorioretinopathy (CSCR) is one of the most common retinal disorders after age-related macular degeneration, diabetic retinopathy, and branch retinal vein occlusion [1]. CSCR is more common in males between 20 and 50 years of age who develop acute or subacute central vision loss or distortion. Other common symptoms include micropsia, metamorphopsia, hyperopic shift, central scotoma, and reduced contrast sensitivity and color saturation [2]. However, progressive diminution of the vision in some cases of chronic CSCR might occur owing to prolonged decompensation of the retinal pigment epithelium (RPE) [3].

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Quick Response Code:

Website: www.jmsr.eg.net

DOI: 10.4103/JMISR.JMISR_101_20

CSCR is thought to occur owing to increase of the permeability of choroidal capillaries in association with RPE dysfunction, causing a serous detachment of the neurosensory retina. Recurrence occurs in ~31–50% of patients with CSCR [4]. Fluorescein angiography (FA) usually shows areas of fluorescein leakage, often focal with smokestack or inkblot pattern in acute CSCR, whereas in chronic stages, the leakage is more diffuse [5]. Spectral domain optical coherence tomography (SD-OCT) allows better

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Submitted: 19-Sep-2020 **Revised:** 13-Dec-2020 **Accepted:** 12-Jan-2021 **Published:** 17-Sep-2021

How to cite this article: Samir G, Elrashidy HE, Atia A. The role of optical coherence tomography angiography in diagnosis of central serous chorioretinopathy. J Med Sci Res 2021;4:229-33.

detection of the areas of pigment epithelium detachment (PED) and serous retinal detachment [6]. CSCR may be complicated with type one choroidal neovascularization (CNV); however, this complication may be difficult to be diagnosed because chronic CSCR and type one CNV share many signs [7].

Optical coherence tomography angiography (OCTA) is a noninvasive imaging modality that allows for detection of blood flow and three-dimensional reconstruction of blood vessels using signal decorrelation between consecutive transverse cross-sectional OCT scans, that is, the concept of OCTA is the detection of changes in blood flow in the vessels in a static eye without dye injection. An OCTA image is computed by comparing, on a pixel-by-pixel basis, repeated B-scans acquired at the same retinal location in rapid succession. The rationale behind OCTA imaging is that in nonmobile tissue the reflected signal will be stationary, and thus the repeated B-scans will be identical. Inside vasculature, however, moving erythrocytes cause a time-dependent backscattering of the OCT signal, which manifests as differences among the repeated B-scans [7].

Basically, OCTA of the posterior pole can be obtained by using one or a combination of two methodologies: amplitude decorrelation and phase-variance. Amplitude decorrelation analyzes amplitude changes in the OCT signal. Split-spectrum amplitude decorrelation divides the spectrum into smaller spectra and performs the repeated B-scan decorrelation separately for each subspectrum, which improves the signal-to-noise ratio [8]. It is considered that OCTA reveals more information about the choriocapillaris that might be beneficial for better understanding of the pathophysiology of CSCR.

Although previous studies compared between FA/ICGA and OCTA [9], especially the B-scan images on OCTA [10], the clinical value of OCTA has not yet been evaluated accurately. So, the aim of this study was to further analyze the OCTA findings in greater number of eyes with CSCR either in acute or chronic stages and to compare them with those obtained through multimodal imaging including SD-OCT and fundus autofluorescence.

Patients and methods

Study population

A series of consecutive patients diagnosed with CSCR at Giza Memorial Institute of Ophthalmic Researches was examined. Our study has included patients either with acute CSCR or chronic CSCR with persistent neurosensory detachment more than 3 months and did not receive any treatment. Patients with history of any chorioretinal diseases or any other ophthalmological condition that could influence the interpretation of clinical and imaging findings for diagnosis of CSCR were excluded. Our study has been approved by the scientific and ethical committe at MIOR.

Study protocol

The patients provided a written consent after informing them that all the procedures conform to the guidelines in the statement for use of patients in ophthalmic and vision research. All patients' demographic data were recorded (sex, age, and race). All patients underwent a complete ophthalmological examination, including best-corrected visual acuity measurement with Snellen chart that was transferred to logMAR, slit-lamp examination, dilated-fundus biomicroscopy, and standardized imaging protocol, using three-dimensional OCT-2000 series (Tokyo 174-8580, Japan), which included FA and SD-OCT. All patients also were subjected to OCTA using a commercially available RTVue XR Avanti with AngioVue (Optovue, Fremont, California, USA). Three-dimensional en-face angiograms are generated by an incorporated software algorithm through decorrelation of two merged consecutive orthogonal registration volumes that centered automatically at the macula or manually centered at the lesion. Each acquired OCTA volume (3 × 3 mm) consisted of 304 × 304 A-scan in 2.6 s, and 6 × 6-mm OCT en-face images (OCTA) were obtained for each patient. Both orthogonal volume scans are combined with a motion correction technology to create a three-dimensional image of retinal and choroidal blood flow. A coregistered OCT B-scan allows the visualization of the retinal structure. RTVue XR Avanti has an automated segmentation at the superficial retinal capillary plexus, deep retinal capillary plexus, outer retina, and choriocapillaris. The OCTA software was used to manually adjust the automated segmentation and its relative depth in the retina and choroid.

The images were acquired by three well-trained OCTA users (Ghada Samir, Alaa Atia and Hussam Omar) who performed a qualitative analysis to determine CSCR features and assess the microvasculature. Our analysis included descriptive statistics (using Microsoft Office Excel software, 2010) for demographics and main clinical data, as well as qualitative descriptions of the imaging findings.

A total of 80 eyes of 80 patients (51 males and 29 females; mean age: 34.5 ± 10 years), diagnosed with CSCR were included in this study. Mean best-corrected visual acuity was 0.23 ± 0.25 logMAR (range: 0–0.8 logMAR, corresponding to 20/20 to 20/125). Overall, 50 (62.5%) eyes had newly diagnosed CSCR, whereas 30 (37.5%) eyes had chronic CSCR with persistent neurosensory detachment more than 3 months. In 12 (15%) eyes, CSCR was associated with type 1 CNV. Tables 1 and 2 show patient demographics and clinical characteristics. The whole population was analyzed, with description of images obtained at different levels. The eyes with abnormal choroidal vessel patterns were described with more details, with an attempt of classification according to the pattern.

Results

In 40 of 80 eyes, it was possible to detect detached retina adjacent to the leakage point in OCTA images, compared with 40 of 80 eyes using FA, and 80 of 80 eyes using SD-OCT. In 44 of 80 eyes, irregular flow patterns were observed on OCTA images through the choriocapillaris. OCTA images

Table 1: The main demographic and clinical features of the study population

Patients (*n*)	80
Male (*n*)	51
Female (*n*)	29
Age (years) (mean±SD)	34.5±10
BCVA logMAR (mean±SD)	0.23±0.25
Acute CSCR (new diagnosis) (*n*)	50
Chronic CSCR (*n*)	30

(n); number, (SD): standered deviation, (BCVA): best corrected visual acuity, (CSCR): central serrous chorioretinopathy

Table 2: Comparison between the three modalities in diagnosis of the main features of central serous chorioretinopathy

	OCTA	SD-OCT	FA
SRD (*n*)	40	80	40
Leaking point (*n*)	0	56	68
Abnormal new vessels (*n*)	12	8	4

FA, fluorescein angiography; OCTA, optical coherence tomography angiography; SD-OCT, spectral domain optical coherence tomography; SRD, serous retinal detachment.

could identify leakage points in only two of the included eyes, compared with 68 of 80 eyes on FA, and 56 of 80 eyes on SD-OCT. In 12 of 80 eyes, abnormal vessels (associated CNV) were observed on OCTA images, mainly of patients with chronic CSCR, compared with eight out of 80 eyes in SD-OCT and four out of 80 eyes in FA.

At the beginning, analysis of the whole population with description of images obtained at different levels was performed. Then, eyes with abnormal pattern of choroidal vasculature were described with more details.

Analysis of optical coherence tomography angiography images

Outer retina

Automatically segmented outer retina OCTA images detected the presence of an abnormal flow in 44 (55%) eyes, whereas no remarkable abnormality in 36 (45%) eyes.

Choriocapillaries

The automated segmentation of choriocapillaris was obtained for all patients. It showed three types of findings: (a) dark areas: they corresponded to diffuse or focal ill delineated areas of low flow in the choriocapillaris layer. This was coregistered with OCT B-scan that revealed a high correspondence between the presence of dark areas and neurosensory detachment, which was observed in 40 (50%) out of 80 eyes (Figs. 1 and 2).

(b) Dark spots: they corresponded to black, single or multiple, well-delineated areas of no flow at the choriocapillaris. These dark spots could be seen alone or in association with dark areas. Coregistration with B-scan revealed a high correspondence with areas of RPE detachment (Figs. 3–5).

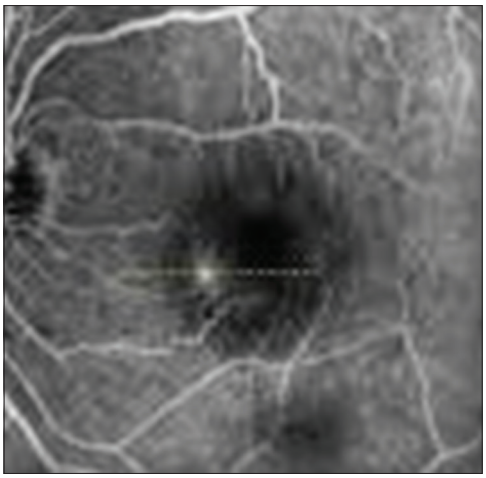

Figure 1: FA: leaking point in CSCR. CSCR, central serous chorioretinopathy; FA, fluorescein angiography.

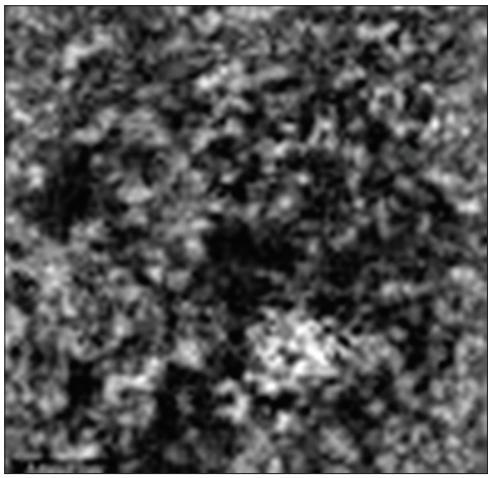

Figure 2: OCTA choriocapillaries: dark areas associated with leaking point. OCTA, optical coherence tomography angiography.

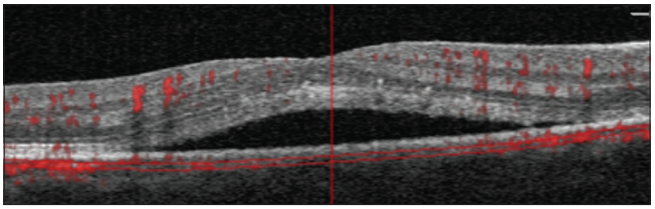

Figure 3: OCTA coregistered B-scan showed reduction of blood flow. OCTA, optical coherence tomography angiography.

(c) Abnormal choroidal vessels: they corresponded to areas of well-defined, high-flow, tangled pattern in the choriocapillaris layer (Fig. 6), as well as an abnormal dilation of choroidal vessels. Coregistered OCT B-scan showed a hyperdense signal that corresponded to the tangled lesion with a typical neovascular network.

Discussion

In our study, we showed OCTA findings in consecutive cases of CSCR in comparison with FA and SD-OCT. Although OCTA

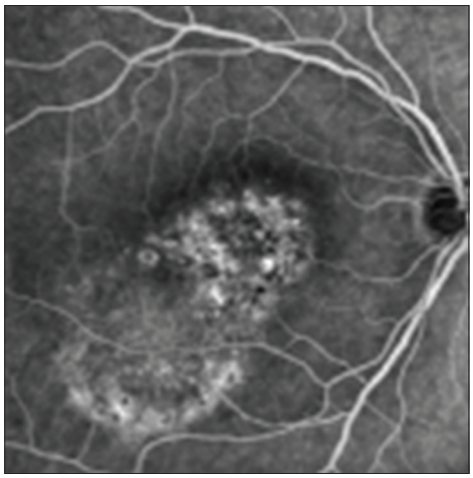

Figure 4: FA: CNV associated with CSCR. CNV, choroidal neovascularization; CSCR, central serous chorioretinopathy; FA, fluorescein angiography.

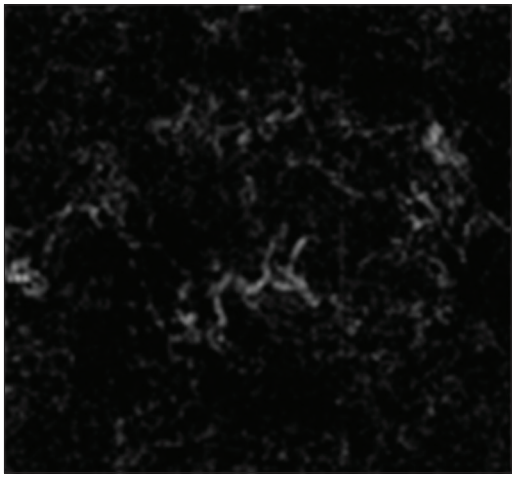

Figure 5: OCTA outer retina: abnormal new vessels. OCTA, optical coherence tomography angiography.

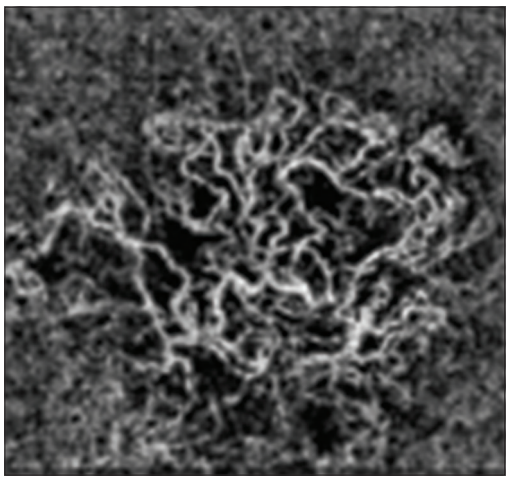

Figure 6: OCTA choriocapillaries: tangled pattern abnormal new vessels. OCTA, optical coherence tomography angiography.

has a big advantage as it can show the changes in blood flow without injecting the dye, but it cannot completely replace FA and SD-OCT in case of CSCR, as through OCTA images, we could not localize the leaking points in all eyes included in the study. On the contrary, the leaking points could be detected by FA in all eyes; this is explained by velocity of the blood cells in the leaking points [10]. OCTA showed irregular choriocapillary blood flow in some cases but not in all of them, as Min *et al.* [11] noticed that the combination between PED and the height of SRF may act as a shield masking the flow signals of choricapillaries on OCTA B-scan, especially if the height is more than 485 μm. This study disclosed dark areas and dark spots at the choriocapillaris, which previously were reported by Costanzo *et al.* [12]. These were explained by changes in honeycomb-like microvasculature at the central fovea. These findings could be owing to attenuation of light by the serous retinal detachment, PED, or elongation of outer segment photoreceptor or all of them. We detected the presence of secondary CNV in some cases of chronic CSCR and detected its position in relation to the RPE and Bruch membrane using OCTA, which gave us information about flow (OCTA) and structure (OCT B-scans). OCTA provides high sensitivity and specificity of detection of CNV associated with CSCR, as it is rarely associated with the excessive subretinal hemorrhage that may limit OCT signal penetration.

Conclusion

OCTA images of the superficial and deep retinal plexus, outer retina, and choriocapillaris did not reveal altered flow patterns directly associated with the leakage point in acute CSCR. However, OCTA was able to visualize altered choroidal flow in some of the included eyes and was the best between all other modalities in detection of CNV in eyes with chronic CSCR.

Acknowledgements

A very special gratitude goes out to all down at Memorial Institute for Ophthalmic Research (MIOR) Dean, Prof. Dr Hanan El Ghonemy, Prof. Dr Laila Elshazly, MIOR CRC President, Prof. Dr Hany Nasr. Thanks to all whole MIOR Staff for their support for helping and providing the suitable facilities for the work. With a special thanks to GOTHI President; Prof. Dr Mohamed Fawzy.

Ethical clearance

Our study has been approved by the scientific and ethical committe at MIOR.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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