OCT Angiography Findings in Acute Central Serous Chorioretinopathy

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BACKGROUND AND OBJECTIVE: To describe optical coherence tomography angiography (OCTA) findings in patients with acute central serous chorioretinopathy (CSC) compared to conventional imaging methods.

PATIENTS AND METHODS: A consecutive series of 11 eyes from 10 healthy patients with acute CSC were included and underwent fluorescein angiography (FA), indocyanine green angiography (ICGA), OCT, fundus autofluorescence (FAF), and OCTA. Obtained OCTA images were evaluated for the presence of serous detachments of the neurosensory retina, leakage points, or other altered findings and compared to conventional imaging devices.

RESULTS: In four out of 11 eyes, it was possible to detect detached retina adjacent to the leakage point in OCTA images, compared with four of 11 eyes using FA, five of 11 eyes using ICGA, 11 of 11 eyes using SD-OCT, and four of 11 eyes using FAF. In five out of 11 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 11 out of 11 eyes on FA, five out of 11 eyes on ICGA, eight out of 11 eyes on SD-OCT, and zero out of 11 eyes on FAF.

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 CSC. However, OCTA was able to visualize altered choroidal flow in some of the included eyes.


INTRODUCTION

Central serous chorioretinopathy (CSC) is a retinal disease of the macula first described by Albrecht von Graefe in 1866. Clinical findings are usually localized serous detachments of the neurosensory retina with consecutive vision impairment and potential complications in form of a choroidal neovascularization.1,2 It is more common in men than women (estimated ratio 6:1), with an annual incidence of 10 per 100,000 in men.3

The pathophysiology of the disease remains unclear but includes an altered regulation of choroidal vessels as well as the involvement of the retinal pigment epithelium (RPE). Known risk factors such as specific personality types (type A personality), obstructive sleep apnea, or glucocorticoid therapy add to the complexity of its pathophysiology.4,5

Possible treatment options include pharmacological interventions with intravitreal anti-vascular endothelial growth factors or mineral corticoid receptor antagonists, as well as photodynamic therapy and laser procedures.6-10

In addition to a full clinical examination, invasive (fluorescein angiography [FA], indocyanine green angiography [ICGA]) and noninvasive (fundus cameras, optical coherence tomography [OCT], fundus autofluorescence [FAF], OCT angiography [OCTA]) imaging techniques can help to diagnose CSC and monitor the course of the disease during therapy. Recently, a noninvasive OCTA system (AngioVue; Optovue, Fremont, CA) was introduced, enabling en face high-resolution vascular imaging of the ocular fundus depicting retinal and choroidal vessels based on a split-spectrum amplitude-decorrelation angiography algorithm.11

The aim of this study was to describe findings of this novel, noninvasive device in patients with acute CSC compared to the use of other invasive (FA, ICGA) and noninvasive (OCT) diagnostic tools.
PATIENTS AND METHODS

A consecutive series of 11 eyes of 10 healthy elderly with acute CSC were included. In all subjects, best-corrected visual acuity was obtained followed by a full clinical examination, including slit lamp biomicroscopy as well as funduscopic evaluation. Acute CSC was diagnosed clinically as CSC by retina specialists confirmed with an FA-based detection of a leakage point. All patients underwent FA, ICGA, OCT, and OCTA. Written informed consent was obtained from all patients prior to invasive imaging. The research adhered to the tenets of the Declaration of Helsinki.

OCTA

Macular OCTA scans (3 mm x 3 mm) were obtained with the recently introduced AngioVue OCTA system, a noninvasive OCT imaging device (70,000 A-scans per second; excitation wavelength 840 nm) based on a split-spectrum amplitude-decorrelation angiography algorithm, providing high-resolution visualization of the vascular structure in three dimensions.11,12

Conventional Imaging Methods

En face FA, ICGA, and FAF images of the macular area, as well as cross-sectional OCT scans of all in-
Excluded patients, were obtained with HRA2 (Heidelberg Engineering, Heidelberg, Germany).

**Image Analysis**

All obtained images (FA, ICGA, OCT, FAF, OCTA) were anonymized and evaluated by two independent retina specialists (NF, LR). FA, ICGA, FAF, and OCTA images were evaluated for depicting the serous detachments of the neurosensory retina, the leakage points, and other altered findings, including the need to use invasive imaging modalities to depict both serous detachments and leakage points.

**Figure 2.** Left eye of a 39-year-old female patient with acute central serous chorioretinopathy. (A, B) Infrared and optical coherence tomography (OCT) image showing retinal detachment and detachment of retinal pigment epithelium. (C) Fluorescein angiography image with leakage point (white circle). (D) Indocyanine green angiography image with leakage point (white circle). (E) Fundus autofluorescence image. (F) OCT angiography (OCTA) image of superficial retinal vessels. (G) OCTA image of deep retinal vessels with rarefication of vessels and discernable area with detached retina (white arrows). (H) OCTA image of outer retina. (I) OCTA image of choroid capillaries with abnormal flow pattern (white arrows).

**Figure 3.** Left eye of a 47-year-old male patient with acute central serous chorioretinopathy. (A, B) Infrared and optical coherence tomography (OCT) image showing retinal detachment and detachment of retinal pigment epithelium (circle). (C) Fluorescein angiography image with leakage point (white circle). (D) Indocyanine green angiography image with leakage point (black circle). (E) Fundus autofluorescence image. (F) OCT angiography (OCTA) image of superficial retinal vessels. (G) OCTA image of deep retinal vessels with central rarefication of vessels and discernable area with detached retina (white arrow). (H) OCTA image of outer retina. (I) OCTA image of choroid capillaries with abnormal flow pattern (white arrows) leakage point cannot be seen in 3F-3I (white circle).
Due to its software, OCTA images through four different levels of the posterior fundus can be analyzed: superficial and deep retinal plexus, outer retina, and choriocapillaris. OCT images were evaluated for depicting the serous detachments of the neurosensory retina and/or retinal pigment epithelium (RPE) detachment as a surrogate parameter for possible leakage (leakage point). Standardized grading protocol can be seen in the Table.

**RESULTS**

A consecutive series of 11 eyes (two right eyes and nine left eyes; eight men and three women) of 10 patients (median age: 45 years ± 9 years) with...
clinically active CSC was included in our prospective study.

Conventional Invasive and Noninvasive Imaging Techniques

Serous detachments could be seen in four of 11 eyes in en face FA images. In seven eyes, it was not possible to differentiate attached from detached retina adjacent to the particular leakage point. As expected, those images were able to identify the leakage point in every included study eye. In five of 11 ICGA images, we could see detached retina and differentiate from attached retina due to a visible “demarcation line.” Also, in five of 11 study eyes, we were able to identify the leakage point in those ICGA images. Cross-sectional SD-OCT scans revealed serous retinal detachment, as expected, in every included eye, whereas RPE detachment as a surrogate parameter for the corresponding leakage point detected in FA images could be seen in eight of 11 study eyes. Looking at FAF images, we were able to differentiate between attached and detached retina due to hypofluorescent patterns of detached retina in five of 11 study eyes. We were not able to identify the leakage point in any of the included eyes when looking only at FAF images.

OCTA Findings

Evaluating the en face OCTA images, we were able to detect areas of abnormal blood flow with hypofluorescence (hypoperfusion) surrounded by hyperfluorescent (hyperperfusion) areas through the choriocapillaris in five of 11 eyes, similar to recently published observations by Teussink et al.13 This observed hypofluorescence did not correlate with the height of detached retina in the evaluated area. In four of 11 eyes, it was possible to detect detached retina adjacent to the leakage point through a visible “contour line” seen in OCTA images through the outer retina. We were not able to identify the leakage point in any of the included eyes looking at various en face images through the inner, medium, or outer retina or choriocapillaris. Similarly to the observed altered choroidal blood flow, we were not able to connect the visibility of detached retina to the height of it or to the subretinal volume in that area.

Figures 1 through 4 show examples of the obtained noninvasive and invasive imaging techniques, including OCTA of the posterior fundus of patients with acute CSC. Figure 5 shows the left unaffected eye of the same patient with acute CSC of his right eye displayed in Figure 4.

DISCUSSION

Imaging techniques of the posterior ocular fundus have developed significantly in the last several years. Noninvasive diagnostic tools such as OCT technology or FAF imaging have become more and more popular and are in the process of replacing invasive diagnostic methods of the ocular fundus such as FA or ICGA. In this context, the AngioVue OCTA has been introduced as the first noninvasive device enabling a high-resolution visualization of the retinal vascular structure in three dimensions by applying a split-spectrum, amplitude-decorrelation angiography algorithm. OCTA has been shown to successfully visualize retinal as well as choroidal vascular structures of the ocular fundus in retinal/chorioretinal diseases, such as neovascularizations in AMD or chronic CSC.11,14,15

In our prospective case series, we first evaluated the images differentiating between the two alterations “serous retinal detachment” and “leakage point,” with its structural surrogate marker, “RPE detachment.” In our findings, a combination of invasive FA and noninvasive OCT imaging results in a 100% detection of both parameters, leaving the need to use the invasive imaging method FA.

However, in our prospective case series with patients with acute CSC, we were not able to detect the leakage point in any of the included patients using noninvasive OCTA. The explanation for this observation is that the leakage point in acute CSC has a very low flow rate of fluid with corpuscular particles, so the difference in fluid extension between two images at two different time points is too small to be visual-
ized in images based on a split-spectrum, amplitude-decorrelation angiography algorithm.

We were able to identify detached retina in one-third of the included eyes (four of 11), observing a wiped out — avascular — area when looking at OCTA images through the outer retina or choroid capillaries. Interestingly, the ability to identify detached retina in OCTA images did not correlate with the height, and, consequently, the expected volume of subretinal fluid, in order to rule out the blocking phenomenon of fluid for our observed avascular area at the location of detached retina. Currently, we do not have a conclusive full understanding for this observation, which will remain a focus of our future investigations on this topic.

Another important aspect worthy of mention is our observation of abnormal blood flow seen in OCTA images through the choriocapillaris in some of the included eyes. This observed abnormal blood flow also did not correlate with the height of detached retina in that area. Teussink et al. also observed irregular flow patterns in OCTA images of patients with chronic CSC, suggesting that the observed focal choriocapillary ischemia combined with hyperperfusion may lead to consecutive subretinal fluid leakage.13 We do not know why we could see those alterations in some patients whereas in other patients we were not able to observe this phenomenon, but it is assumed that acute CSC may occur in various intensities consecutively showing possible various stages of affected choriocapillaris.

Limitations of our prospective case series are a low number of included study eyes and the fact that we do not know when exactly the retinal structures began to alter due to the disease. More studies with a longitudinal character have to be conducted to better observe and understand the findings of noninvasive OCTA in first acute and then chronic CSC.

In summary, we were able to show that noninvasive OCTA was able to visualize altered choroidal flow and detached retina in some patients with acute CSC independent of the height of detached retina at that site.

REFERENCES