Polskie Towarzystwo Okulistyczne
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KLINIKA OCZNA 2023, 125, 3: 146-150
Received: 5.09.2022 **Accepted:** 24.12.2022

REVIEW ARTICLE

Access this article online

Website:
www.klinikaoczna.pl

DOI:
https://doi.org/10.5114/ko.2023.131905

Image of serpiginous choroiditis in swept-source optical coherence tomography angiography – a review of the literature

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ABSTRACT

Serpiginous choroiditis (SC) is a bilateral, asymmetrical choroid inflammation leading to the loss of choriocapillaris, overlying retinal pigment epithelium (RPE), and outer retina causing the severe decrease of vision. This condition was initially diagnosed in patients with tuberculosis and syphilis, while autoimmune disorders are now considered to underlie this entity. Optical coherence tomography angiography (OCTA) is comparable to other invasive methods such as fluorescein angiography (FA) and indocyanine green angiography (ICGA) in diagnosing and monitoring the severity of the pathology mentioned above.

KEY WORDS: optical coherence tomography angiography, serpiginous choroiditis, fluorescein angiography.

Serpiginous choroiditis (SC) is recurrent posterior uveitis, classified as a rare group of diseases termed "white-dot syndromes", as described by Ezra in 1995 [1]. It is a relatively rare condition, accounting for between 0.2% and 5% of all uveitis. The disease is most prevalent in southern African countries, which may be related to an infectious background [2, 3]. Literature data also show a frequent occurrence of SC in Germany and the United States [4, 5].

The etiology of SC is not fully understood, autoimmune processes are considered, and the role of infectious agents such as *Mycobacterium tuberculosis*, viruses, *Toxoplasma gondi*, *Candida* spp. cannot be excluded [3].

Based on the histological report by Wu *et al.* serpiginous choroidopathy is characterized by inflammation, localized originally in the choroid with extensive infiltration by lymphocytes. This infiltration is greatest at the margins of the atrophic scars. The scarring is characterized by loss of retinal pigment epithelium (RPE) and photoreceptor layer with localized defects in the underlying Bruch membrane. These features of serpiginous choroidopathy can be identified and monitored by optical coherence tomography (Figures 1, 2). Fibroglial tissue was found above the inner surface of Bruch's membrane and its invasion was noted in the choroid through the brakes in Bruch's membrane [6, 7].

Serpiginous choroiditis is a primary choriocapillaropathy, usually occurring bilaterally and asymmetrically, progressing in a centrifugal manner. It affects people between 20 and 60 years old and is initially asymptomatic until the disease process involves the macula [7]. The patients complain of gradual blurring of vision, scotomas, and metamorphopsia. Eventually, irreversible vision loss occurs when the disease spreads into the macula [8, 9].

There are three types of SC depending on the primary location of the inflammation [10, 11]. The "peripapillary form" accounts for about 80% of all cases. It starts initially near the optic disc and progresses towards the macula. Another type of SC is the "macular form" with a poor prognosis of vision due to early primary manifestation in the macula. The last form - „atypical"- localizes within the peripheral area multifocally. It may progressively reach the macula and possibly initiates acute posterior multifocal placoid pigment epitheliopathy [12]. To diagnose SC, tuberculosis-related uveitis has to be excluded [13].

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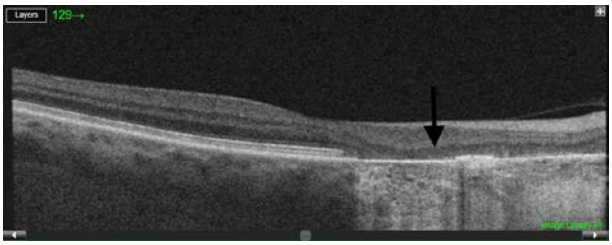

Figure 1. Choroidal changes in the right eye with inactive serpiginous choroiditis (Swept-source optical coherence tomography B-scan). The black arrow shows the clear loss of choriocapillaris, retinal pigment epithelium, inner segments, and cones outer segment tips in the nasal part of the macula in the right eye

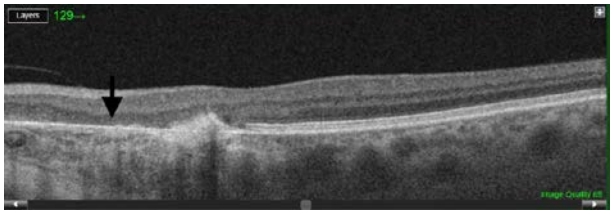

Figure 2. Choroidal changes in the left eye with inactive serpiginous choroiditis (Swept-source optical coherence tomography B-scan). The black arrow shows the clear loss of choriocapillaris, retinal pigment epithelium, inner segments, and cones outer segment tips in the nasal part of the macula in the right eye

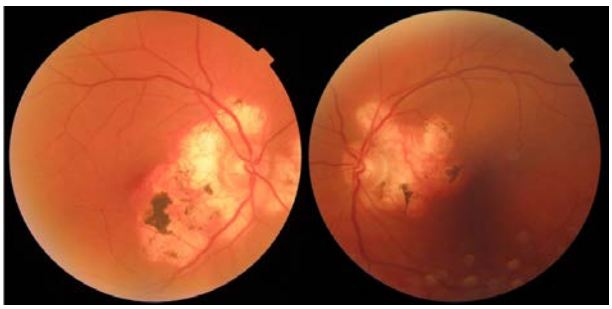

Figure 3. The fundus photography of the right eye (on the left) and the left eye (on the right) in a patient with serpiginous choroiditis

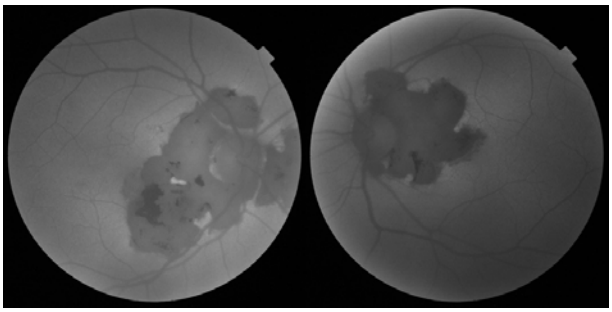

Figure 4. Fluorescein autofluorescence of the right eye (on the left) and the left eye (on the right) in a patient with serpiginous choroiditis

There is no proper consensus on the optimal treatment of SC. Immunosuppressive and biological treatments are usually used, but despite therapy, recurrences are observed [14, 15].

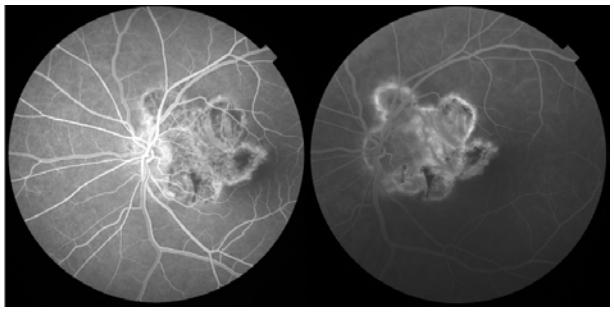

Figure 5. Fluorescein angiography of the left eye in a patient with serpiginous choroiditis: the early (on the left) and the late (on the right) phase

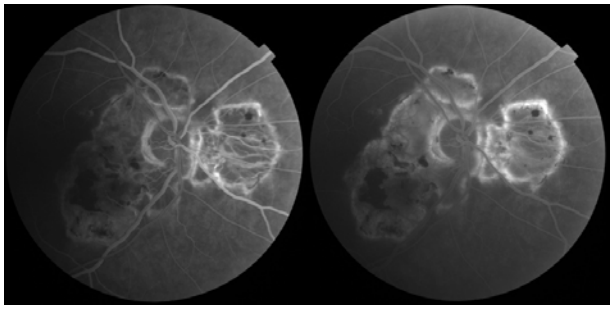

Figure 6. Fluorescein angiography of the right eye in a patient with serpiginous choroiditis: the early (on the left) and the late (on the right) phase

A fundus examination reveals wavy or ameboid-like lesions in the choroid (Figure 3). The choroiditis usually progresses as irregular serpentine lesions centrifugally. These lesions initially have the appearance of ill-defined patches of greyish-white or creamy-yellow colour at the level of the outer retina or RPE. The overlying retina may be swollen due to the underlying inflammation, leading even to severe serous retinal detachment. The healing of the above inflammatory lesions is variable with or without treatment and lesions are observed at different stages of regression. Active lesions regress usually within 6-8 weeks and are characterized by the sharpening of the border with irregular RPE hyperperturbations, diffuse RPE mottling with extensive atrophy of RPE, and choriocapillaris. Sometimes the atrophy of RPE and choriocapillaris is so extensive that the underlying large choroidal vessels shine through and atrophy of the above layers may expose the sclera. Relapses are common and usually start at the margins of previously healed lesions. Intervals between recurrences vary from months to years [16].

Methods such as fundus autofluorescence (FAF), fluorescein angiography (FA), and indocyanine green angiography (ICGA) are used in the diagnosis of SC. The ICGA shows the true extent of choriocapillaropathy. The above methods focus on the retina, RPE, and choroid, but are not always available. Optical coherence tomography angiography (OCTA) is a new 3D non-invasive diagnostic method for imaging the retinal and the choroidal vasculature without the use of dye, the results of which can be compared to FA and ICGA [17-19].

In FAF, active SC is characterized by a peripheral hypoautofluorescence area surrounding the hyperauto-

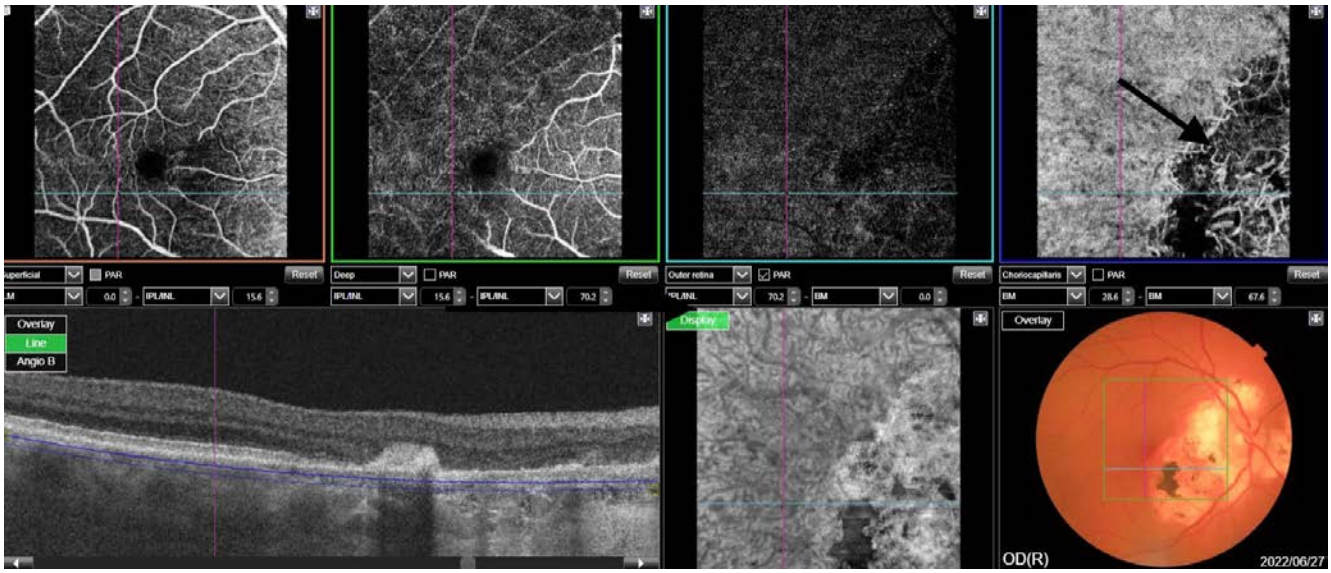

Figure 7. Swept-source optical coherence tomography (OCT) of the right eye in a patient with serpiginous choroiditis. OCT B-scan outlines (blue line) the Satler's layer (manually corrected), which corresponds to the atrophic changes of the Satler's layer in OCTA (black arrow)

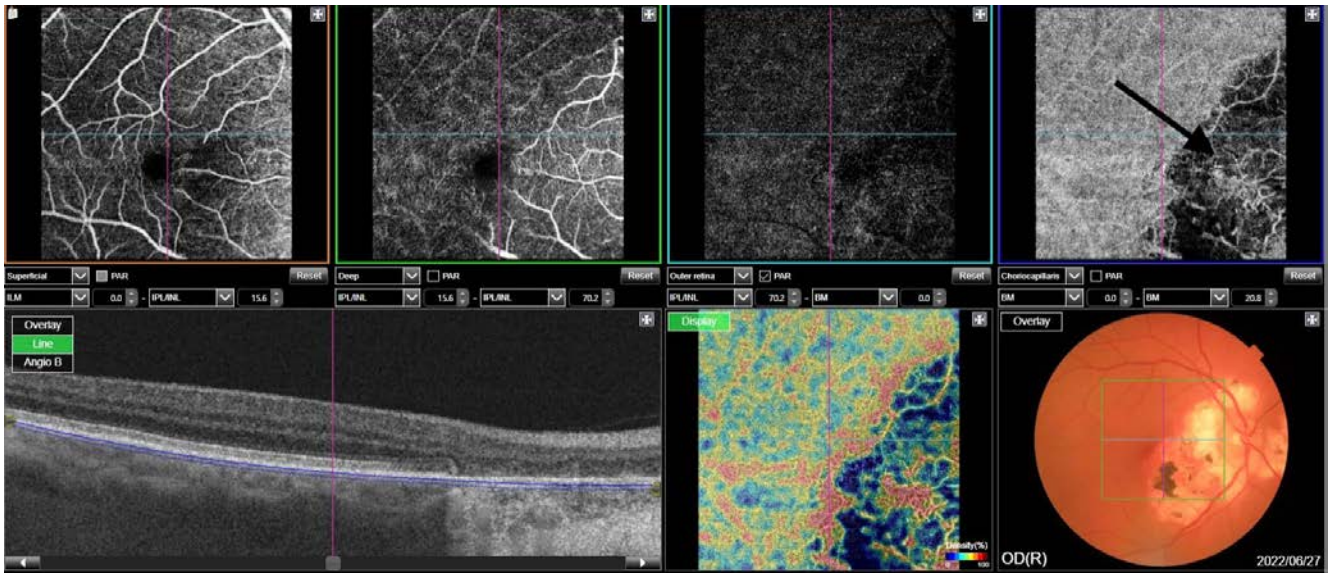

Figure 8. Swept-source optical coherence tomography (OCT) of the right eye in a patient with serpiginous choroiditis. OCT B-scan outlines (blue line) the choriocapillaris layer (automatically segmented basement membrane and the manually corrected choriocapillaris), which corresponds to the atrophic changes of the choriocapillaris in OCT angiography (black arrow)

fluorescent borders of the lesions (Figure 4). The old, nonactive areas are completely hypofluorescent because of the loss of choriocapillaris [20, 21]. In FA, active SC shows hypofluorescent areas surrounded by hyperfluorescent borders, with staining and leakage of contrast in the late phases (Figures 5, 6). The inactive SC areas are hypofluorescent in the early stages, acquiring a hyperfluorescent edge in the late phases. ICGA visualizes hypofluorescent lesions throughout the examination usually with greater coverage than the FA [22, 23].

Although SC is a rare disease, the authors working on this issue have demonstrated the reliability of a technique such as OCTA in the diagnosis of SC over existing diagnostic methods (ICGA, FA, FAF) [7, 24].

Swept-source (SS) OCT and OCTA use a longer central wavelength (1050 nm), improving resolution and signal penetration through the RPE, choriocapillaris (at 10 ±0 μm^2 below the Basement Membrane, BM), and choroidal vessels; Sattler's Layer (at 70 ±10 μm^2 below BM) and Haller's Layer (at 140 ±10 μm^2 below the BM) [25]. SS-OCTA helps identify and monitor the choriocapillaris layer, where SC is most likely to start [26].

Kaivon *et al.* proposed an assessment of the severity of retinal and choroidal damage in SC based on SS-OCT, FAF,

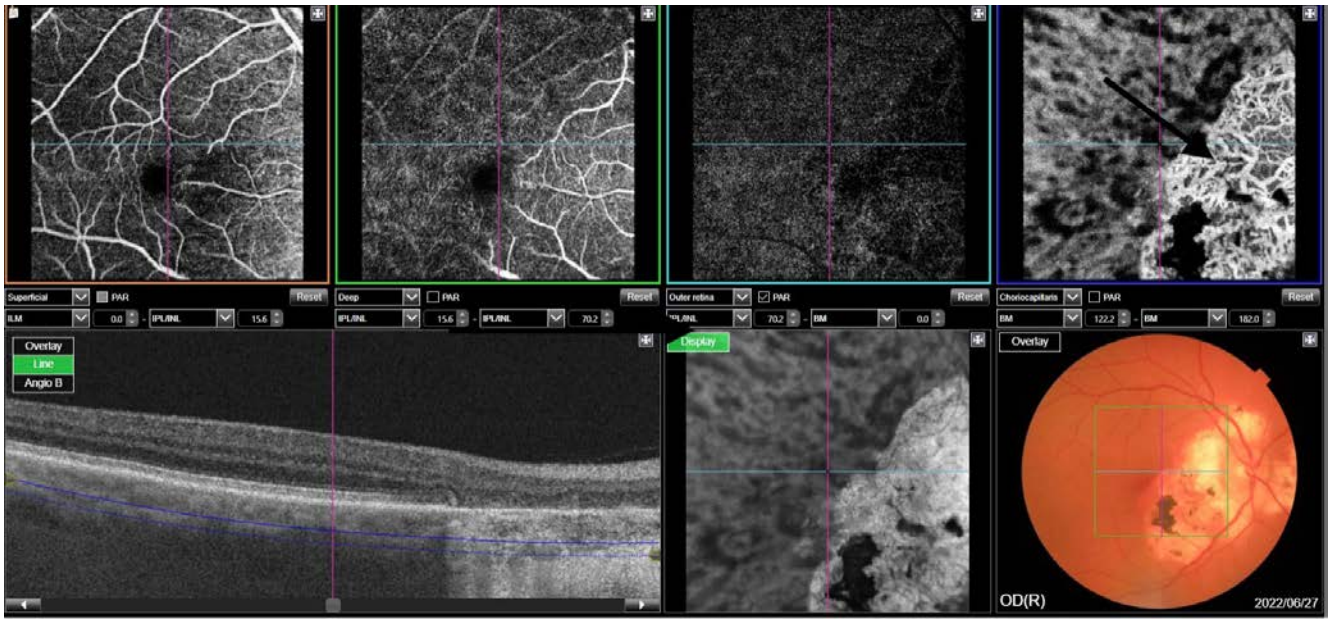

Figure 9. Swept-source optical coherence tomography (OCT) of the right eye in a patient with serpiginous choroiditis. OCT B-scan outlines (blue line) the Haller's layer (manually corrected), which corresponds to the atrophic changes of the Haller's layer in OCTA (black arrow). The middle window in the bottom row shows the "White on Black effect" in Haller's Layer

and ICG. SC Lesion Grade based on Multimodal Imaging distinguishes acute and chronic stages of SC. In the acute stage of SC, three grades are depending on anatomic involvement. Grade 1 includes damage to the choriocapillaris, which we can visualize using SS-OCTA or ICG. Grade 2 includes Grade 1 and additional damage to the outer retina up to the outer nuclear layer (ONL) based on SS-OCT. Grade 3 includes Grade 2 and damage to the RPE, which is visible in FAF as hyperautofluorescence. The chronic phase of the SC is recognized as hypoautofluorescence within the SC in FAF [26].

Macedo *et al.* reported 12 patients with SC proving that the extent of damage in the course of this disease remains constant throughout FA, ICGA, FAF, OCT, and enhanced depth imaging optical coherence tomography (EDI-OCT) with the possibility of better imaging of the deeper layers of the choroid by OCTA. Using OCT, they demonstrated changes in the layers of large choroidal vessels located below the choriocapillaris: in Sattler's layer lying immediately below the choriocapillaris (Figure 7), which was identified by vessel-like entities in a hyperintense greyish background and the next, deeper Haller's layer, an area of hypo- and hyperintense signals corresponding to larger vessels. The loss of the choriocapillaris layer and RPE (Figure 8) results in a "window defect", whereas the larger caliber vessels (Haller's layer) are detectable and their appearance inverted causing a "white-on-black" effect (a large white area on a black background corresponding grossly to the atrophic area) (Figure 9). In addition, EDI-OCT shows geographic atrophy with the RPE and choroidal thinning and loss of the ellipsoid portion of the inner segments (EPIS) and cones outer segment tips (COST). Macedo *et al.* further demonstrated loss of inner retinal layers in more advanced stages of atrophy in SC, resulting in increased visibility of the choroid, which was isoreflective. In their study, OCTA imaging showed hypo-perfused choriocapillaris in all 12 patients with SC, which compared well with the atrophic areas found on EDI-OCT [24].

OCTA examination can demonstrate the presence of choroidal neovascularisation (CNV) as an expression of the active phase of SC, even if ICGA cannot confirm this condition as reported by Mandali *et al.* in tuberculous serpiginous-like choroiditis [27].

In conclusion, OCTA is a non-invasive, increasingly available, and clinically valuable test in diagnosing and monitoring SC. This tool's quality is comparable to other invasive tests such as FA and ICG in detecting and assessment of disease progression.

DISCLOSURE

The authors declare no conflict of interest.

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