• Letter to the Editor •

Choroidal infarction after internal carotid artery stenting

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Dear Editor,

We present a case of choroidal infarction along with retinal infarction after carotid artery stenting (CAS), which is a rare condition not reported in the literature. CAS has increasingly been accepted as the mainstay reconstruction method for carotid artery stenosis compared with carotid endarterectomy (CEA) due to no need for general anesthesia, limited surgical trauma and no need for access to hostile neck anatomy. However, a higher incidence of retinal embolization has been reported after CAS (16.9%) compared with CEA (4.9%)[1], and the incidence of all retinal artery embolization during CAS is 5%–16.9% and that of symptomatic retinal artery occlusion (RAO) is 1.4%–1.7%[2-3]. It is notable that the posterior ciliary arteries (PCAs) that supply the choroid also come from the ophthalmic artery, and choroidal embolization is theoretically possible to occur after CAS. However, to the best of our knowledge, case with retinal embolization together with choroidal embolization after CAS has never been reported. Herein, we report such a case with detailed pre-operative and post-operative ocular findings which may increase our knowledge on the changes of ocular haemodynamics after CAS. This study complied with the principles of the Declaration of Helsinki and was approved by the Institutional Review Board of Sichuan University, West China Hospital (Chengdu, China). Informed consent was obtained from the patient for this case to be presented and discussed.

CASE REPORT

A 68-year-old male presenting with transient loss of consciousness and fall followed by left-sided limb weakness was found to have high-grade (90%) stenosis at his proximal right internal carotid artery (ICA) *via* diagnostic angiography. Medical record revealed no other systemic disease other than a history of hyperlipemia. One day before the surgery, the patient received detailed ocular examinations. Best corrected visual acuity was 20/20 for both eyes. Intraocular pressure (IOP) was 12.3 and 12.8 mm Hg for the right and left eye, respectively. Fundus photograph using Clarus^{TM} (CLAURUS 500^{TM}, Carl Zeiss Meditec Inc., Californea, USA) and ultra-widefield optical coherence tomography angiography (OCTA) images using a 400 kHz swept-source OCTA instrument (BM-400K BMizar TowardPi Medical Technology, Beijing, China) were unremarkable (Figures 1 and 2). During the CAS, balloon angioplasty and stenting of the proximal cervical ICA was performed without apparent complications, and a distal filter cerebral protection device was deployed in the distal cervical ICA throughout the procedure. Fine position of the stent and brisk restored anterograde flow were confirmed before the ending of the surgery.

Two hours after the procedure, the patient had several emeses and noted orbital pain of the right eye with vision changes. Ophthalmology was consulted and whitening of the superior temporal quadrant of the retina was observed in the right eye using funduscope, but for the unstable vital signs of the patient, detailed ophthalmic examination was not obtained immediately. The patient was then administered therapies for the purpose of dilating the blood vessels including regular aspirin and anticoagulants. At 6d after CAS, detailed ophthalmic examination was obtained. The best corrected visual acuity was 20/25 and 20/20 for the right and left eye, respectively. IOP was 7.5 and 13 mm Hg for the right and left eye. Dilated fundus photographs revealed superior temporal quadrant of retinal whitening consistent with superior temporal branch retinal artery occlusion (BRAO; Figure 1). Multiple intra-arterial emboli were presented (Figure 1). Besides, at the very periphery temporal and nasal regions of the retina, two triangular white lesions with the cusp pointing at the macular was noticed (Figure 1). On ultra-widefield OCTA, in the region of RAO, decreased vascular perfusion of the superficial capillary and deep capillary plexus was presented along with decreased perfusion of the choriocapillaris, indicating both retinal and choroidal occlusion (Figure 2). Besides, within the periphery temporal region of the triangular lesion, decreased

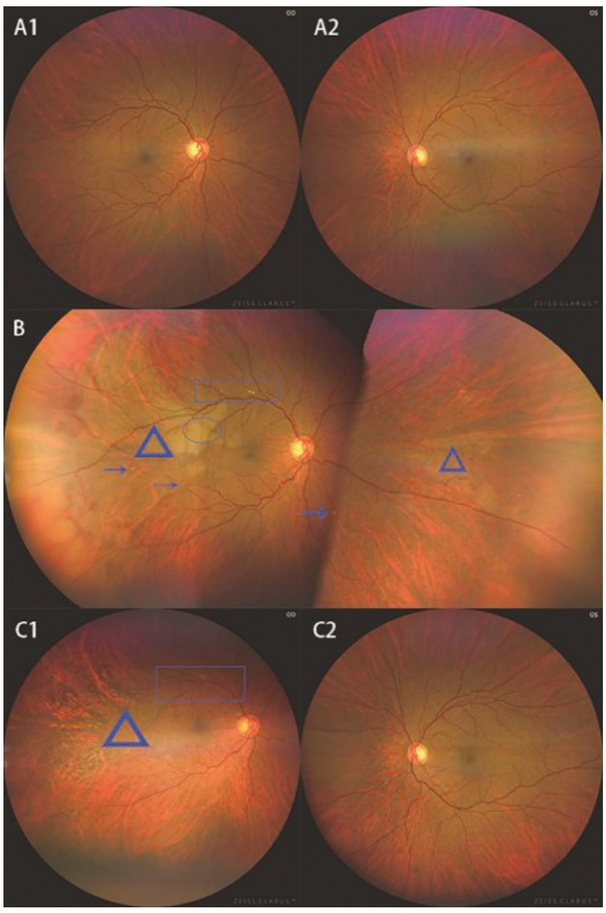

Figure 1 Color fundus photographs of BRAO and SPCAO in this case caused by CAS A1, A2: Normal color fundus photograph of the right and left eye before CAS; B: Montage fundus photograph of the right eye at 6d after CAS showing segmental embolization of the branch retinal artery at the superior temporal quadrant (blue rectangle) and retinal whitening and edema (blue ellipse) in the corresponding area. Multiple visible intra-arterial emboli at the bifurcation of the retinal arteries (blue arrows). Two triangular white lesions with the cusp pointing at the macular were demonstrate at the very nasal and temporal regions of the retina (blue triangle). C1: Fundus photograph of the right eye showing white line of the superior temporal artery (blue rectangle) and retinal atrophy and retinal pigment epithelium changes at the region of BRAO and SPCAO (blue triangle) at 6wk after CAS. C2: Normal fundus of the left eye at 6wk after CAS. BRAO: Branch retinal artery occlusion; SPCAO: Short posterior ciliary artery occlusion; CAS: Carotid artery stenting.

perfusion of the choriocapillaris was observed (Figure 2). The triangular lesions were also illustrated in the fundus fluorescein angiography (FFA) images (Figure 3). This patient was diagnosed with BRAO and the short posterior ciliary artery occlusion (SPCAO). Oral drugs aiming at invigorating the circulation of blood was administered. Two weeks after CAS, mildly improved perfusion of the superficial capillary and deep capillary plexus as well as adequately improved choroidal perfusion could be visualized within the region of BRAO and SPCAO in ultra-widefield OCTA images (Figure 2). Six weeks

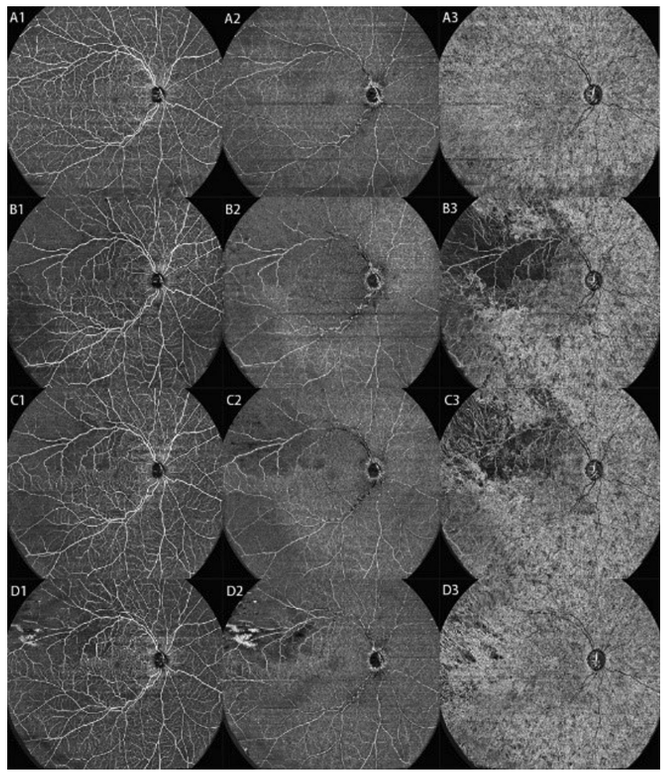

Figure 2 OCTA images of BRAO and SPCAO in this case caused by CAS Ultra-widefield OCTA imaging of the right eye showing normal superficial capillary (A1) and deep capillary plexus (A2) perfusion of the retina and normal perfusion of the choriocapillaris (A3) before CAS. Six days after CAS, decreased superior temporal superficial capillary (B1) and deep capillary plexus (B2) perfusion as well as significantly decreased perfusion of the choriocapillaris (B3) was demonstrated. Follow-up at 2wk and 6wk after CAS demonstrated partial recovery of superficial capillary (C1, D1) and deep capillary plexus (C2, D2) perfusion and significant recovery of the perfusion of the choriocapillaris (C3, D3). OCTA: Optical coherence tomography angiography; BRAO: Branch retinal artery occlusion; SPCAO: Short posterior ciliary artery occlusion; CAS: Carotid artery stenting.

after CAS, best corrected visual acuity improved to 20/20 of the right eye. IOP was 11.5 and 15.3 mm Hg for the right and left eye, respectively. Further improvement of choroidal perfusion (Figure 2) was observed. However, the occluded retinal vessel appeared as a white line and retinal atrophy in the corresponding area remained (Figure 1).

DISSCUSION

The retinal arteries nourishing the inner retina are supplied by the ophthalmic artery, which is the first branch of the ICA. It is not difficult to understand that patients with carotid stenosis undergoing CAS are prone to embolization in the retinal arteries[4]. Cerebral protection devices placed in the ICA are now widely used in CAS to filter the atherosclerotic debris from the plaques, but emboli may travel from the external carotid artery to the ophthalmic artery and finally reach the retina[5].

The choroid is supplied by the PCAs which also derive from the ophthalmic artery. However, occlusion of the PCA has

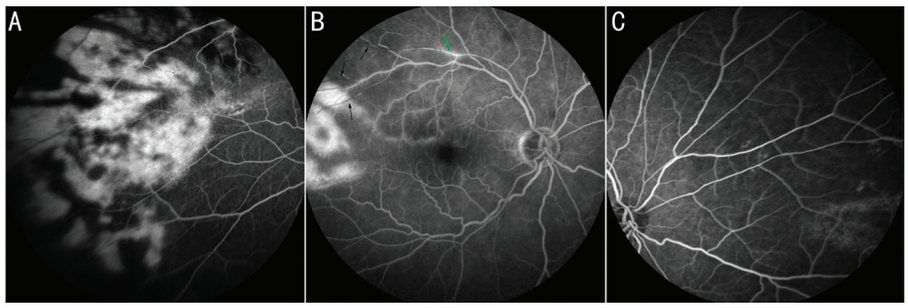

Figure 3 Fundus fluorescein angiography images of BRAO and SPCAO in this case caused by CAS A, C: Fundus fluorescein angiography of the right eye at 6d after CAS showing a new and an old triangular-shaped lesion with the cusp pointing at the macular with late patchy hyperfluorescence at peripheral temporal and nasal regions of the retina corresponding to choroidal infarcts caused by SPCAO. B: Delayed filling (black arrows), emboli (green arrow) and perivascular leaking in the superior temporal artery of the right eye were demonstrated. BRAO: Branch retinal artery occlusion; SPCAO: Short posterior ciliary artery occlusion; CAS: Carotid artery stenting.

rarely been reported and discussed in the literature. Before the advent of OCTA, indocyanine green angiography was the only access to observe the choroidal circulation, but patients with single PCA occlusion may present with mild symptoms and thus being ignored. Even with OCTA, periphery choroidal infarcts are also difficult to be recognized since the range of scanning field is limited. In this case, we obtained pre-operative and post-operative ultra-widefield OCTA images and montage fundus photographs as well as FFA images to illustrate the occlusion of PCA in the patient after CAS, which is an important finding of choroidal blood flow changes of patients undergoing CAS. In 2004, Utsugi *et al*[6] reported multiple occlusions in the choriocapillaris in the posterior pole and/or the midperiphery in patients with carotid artery stenosis using wide-angle indocyanine green angiography. Recently, researchers have found decreased choroidal perfusion in patients with carotid artery stenosis and improved perfusion after reconstruction surgery[7-8]. The choroid may serve as an important but usually ignored reflection of ocular hemodynamic changes in patients with carotid artery stenosis and further research is needed to explore its significance.

Retinal and choroidal embolization are possible complications following the procedure of CAS. Ultra-widefield OCTA images are helpful in evaluating and monitoring the changes of choroidal vasculature. Ophthalmologists and interventional radiologists should be aware of the risk of retinal and choroidal embolization, and further research of the relationship of choroidal vasculature and carotid artery stenosis is needed.

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