



## Paracentral acute middle maculopathy following internal carotid artery stenting

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### ABSTRACT

**Purpose:** To report a case of paracentral acute middle maculopathy (PAMM) that presented after internal carotid artery stenting despite the use of a filter embolic protection device.

**Observations:** A 74-year-old man presented one week following transfemoral stenting of the right internal carotid artery for high-grade stenosis. A filter-type embolic protection device was used during the stenting procedure to prevent distal embolization of atherosclerotic debris. Dilated examination of the right eye revealed a parafoveal gray lesion in the macula and optical coherence tomography showed a corresponding placoid hyperreflective band at the level of the inner nuclear layer consistent with PAMM. The patient was asymptomatic. At 10 weeks follow up the PAMM lesion was resolved.

**Conclusions:** PAMM occurred following internal carotid artery stenting despite the use of a filter embolic protection device, likely due to embolic debris passing through the filter device or debris released while the filter was in a collapsed state. The PAMM lesion was small and resolved without visual sequelae.

### 1. Introduction

Carotid artery stenting is an option for the treatment of carotid artery stenosis in select patients.<sup>1</sup> Atherosclerotic debris is commonly generated at the time of carotid stenting and may cause embolic complications.<sup>2,3</sup> Embolic protection devices have been developed to prevent the embolization of released debris.<sup>2,3</sup> There are different types of embolic protection devices; filter devices are the most widely used for carotid artery stenting.<sup>2</sup> At the beginning of the procedure, the filter is advanced in a collapsed state within the carotid artery on a guide wire beyond the stenosis to be stented and then deployed. The filter then captures debris released during the stenting procedure. Following stent placement, the filter is collapsed and removed along with any captured debris.<sup>2,3</sup> Herein, we report a case of paracentral acute middle maculopathy (PAMM) that presented following carotid artery stenting despite the use of a filter-type embolic protection device.

### 2. Findings

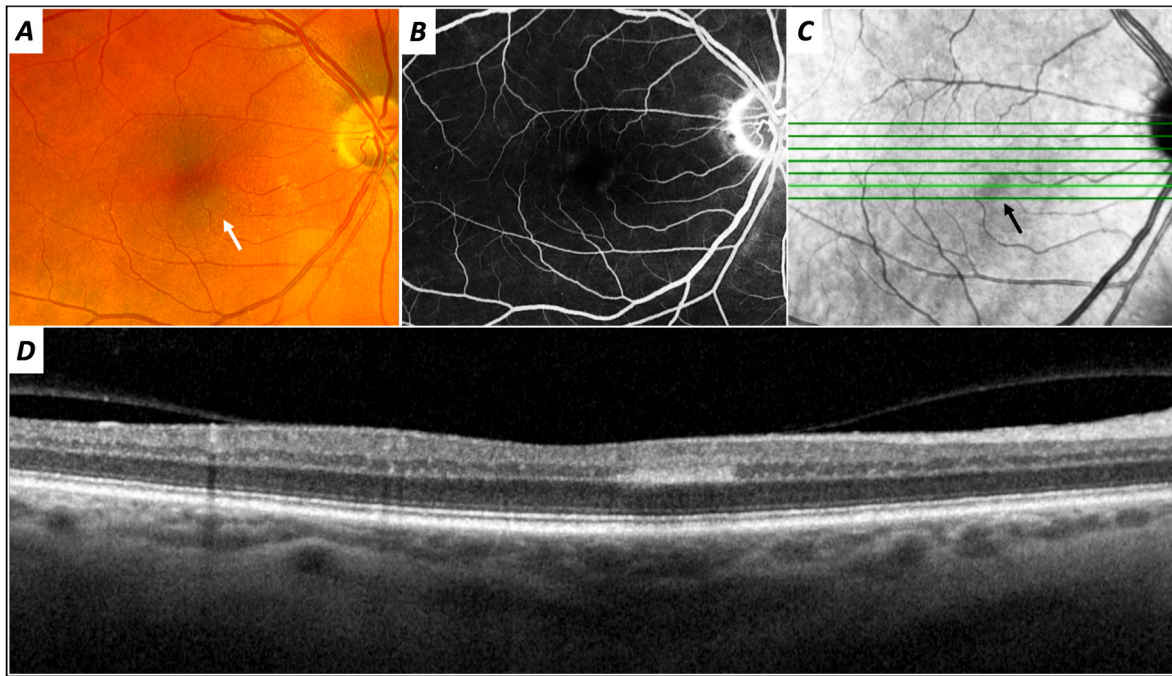
A 74-year-old man with a history of hypercholesterolemia, hypertension, type 1 diabetes mellitus, and left eye macular hole repair

presented to the retina clinic for routine follow up one week following transfemoral stenting of the right internal carotid artery for high-grade stenosis. A filter-type embolic protection device was used during the procedure and deployed in the distal cervical internal carotid artery prior to angioplasty and stent placement. The carotid stenting procedure was noted to be uncomplicated and successful, with reduction in the degree of stenosis from 80% to 0%. Immediately prior to starting the procedure, the patient's blood pressure was 160/74 mm Hg, and during the procedure it ranged from a low of 64/38 mm Hg to a high of 149/71 mm Hg.

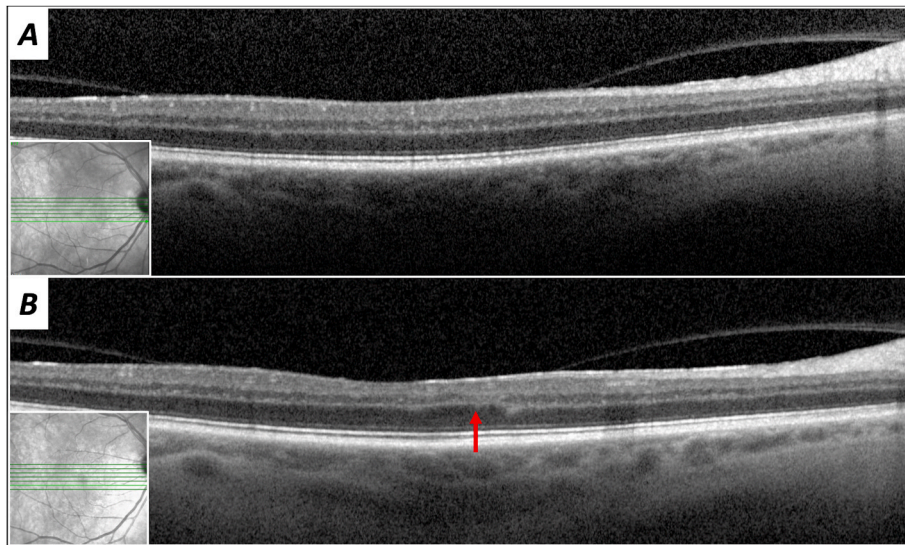
Vision was 20/20 in the right eye and 20/80 in the left (the decreased vision in the left eye was attributable to the history of macular hole). Dilated examination of the right eye revealed a subtle parafoveal gray lesion in the macula (Fig. 1A). No emboli were visible. Fluorescein angiography showed no vascular filling defects (Fig. 1B). En face near-infrared reflectance imaging showed a paracentral hyporeflective macular lesion (Fig. 1C) and optical coherence tomography (OCT) showed a placoid hyperreflective band at the level of the inner nuclear layer consistent with PAMM (Fig. 1D). He was asymptomatic. OCT imaging from an examination one month prior to the carotid procedure did not show PAMM (Fig. 2A).

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**Fig. 1.** Fundus photograph of the right eye (A) shows a subtle parafoveal gray lesion (white arrow). Fluorescein angiography (B) shows no vascular filling defects. En face near-infrared reflectance (NIR) imaging (C) demonstrates a paracentral hyporeflective macular lesion (black arrow). Horizontal optical coherence tomography (OCT) scan (D) through the lesion shows a hyperreflective band at the level of the inner nuclear layer consistent with paracentral acute middle maculopathy. The location of the OCT cross section is shown on the NIR scan (C).



**Fig. 2.** OCT scan of the right eye one month prior to the carotid stenting procedure shows no evidence of PAMM (A). 10 weeks after the PAMM lesion had been found, there is inner nuclear layer thinning (red arrow) in the area where the lesion had been (B). Inset NIR scans show the location of the corresponding OCT cross sections. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

10 weeks following the initial discovery of the PAMM lesion, repeat OCT showed inner nuclear layer thinning in the area where the lesion had been (Fig. 2B). The patient remained asymptomatic with 20/20 vision.

### 3. Discussion

Debris ranging in size from 1 to 5000  $\mu\text{m}$  may be released from atheromatous plaques at the time of carotid stenting.<sup>2</sup> Most filter embolic protection devices have pores that filter particles greater than 100  $\mu\text{m}$  in size (filters with smaller pore sizes are susceptible to

thrombosis, which inhibits antegrade flow).<sup>2</sup> This means that small particles may pass through the filter pores. The diameters of the pre-capillary arterioles and retinal capillaries are 45  $\mu\text{m}$  and 5  $\mu\text{m}$ , respectively.<sup>4</sup> PAMM is characterized by a placoid hyperreflective lesion at the level of the inner nuclear layer on optical coherence tomography and is believed to represent ischemia of the deep retinal capillary plexus system.<sup>5,6</sup> Therefore, in the case reported here it is conceivable that a small particle released at the time of stenting could have passed through the filter in the internal carotid artery, traveled distally to the retinal circulation, and resulted in transient pre-capillary arteriolar and/or retinal capillary ischemia leading to PAMM. Alternatively, the debris

could have been released when the filter was in a collapsed state.<sup>3</sup>

Collateral vascular pathways may occur between the external carotid artery and the ophthalmic artery, thereby providing an alternate route for blood flow to the retina.<sup>7</sup> These collateral pathways may enlarge in the setting of internal carotid stenosis and may be identifiable on carotid angiography.<sup>7</sup> It has been noted that retinal embolization may occur during carotid stenting, despite the use of an embolic protection device, through anastomotic pathways from the external carotid to the ophthalmic artery.<sup>7,8</sup> Therefore, a third possible mechanism for our case is that a small particle traveled through a collateral pathway from the external carotid to the eye resulting in PAMM, though such collateral vessels were not noted in the patient's preprocedural carotid imaging.

Though less likely, it is also possible that the PAMM lesion was coincidental to the carotid stenting. The patient was asymptomatic, therefore it is not possible to ascertain precisely when the PAMM first developed. PAMM has been associated with hypertension,<sup>9</sup> and the patient had a history of hypertension and was found to be hypertensive immediately prior to and during the procedure, therefore this could serve as an alternative explanation. However, given the location of the PAMM lesion on the same side as the stenting procedure, short time period between the procedure and detection of the lesion, and plausible mechanism of small particle embolization, we believe it is most likely that PAMM occurred secondary to the stenting procedure.

PAMM has been reported after endovascular coil embolization<sup>10</sup> and after cardiac catheterization.<sup>11,12</sup> In their case report of PAMM following cardiac catheterization, Schmitt and colleagues proposed that the ischemia may have occurred secondary to an embolism induced by intra-aortic vascular trauma.<sup>12</sup> Our report adds to the literature on the association between PAMM and endovascular procedures.

#### 4. Conclusions

PAMM occurred following carotid stenting despite the use of a filter-type embolic protection device. We believe this was most likely due to debris passing through the device filter or debris released while the filter was in a collapsed state. Fortunately, the patient was asymptomatic owing to the small area of ischemia.

#### Patient consent

Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to identification of

the patient.

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Conflict of interest: None of the authors have a proprietary interest in the material presented in this study.

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Research ethics: This study was submitted to the Northwest Permanente Institutional Review Board and determined to be exempt from review.

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