

found to have a redetachment. In addition, 2 patients (4%) were seen in casualty with pain in their eye before their consultation and were found to have a raised IOP and were treated accordingly. After the phone consultation, a further 3 patients presented to the VRE unit with a redetachment over the next 6 months since their surgery. There were no reports of other postsurgical complications such as endophthalmitis, vitreous haemorrhage, optic capture, or optic neuropathy.

Patient satisfaction surveys are an essential source of information for identifying gaps in clinical care and planning quality improvement within health care organizations.³ Our patient survey revealed that two-thirds of patients were willing to consider replacing face-to-face consultations with a telephone consultation, even after the pandemic. However, owing to the risk of missing patients with asymptomatic raised IOP, perhaps, a single visit at 2 weeks followed by a telephone consultation for those with a long-acting gas may be a suitable compromise. We did not report any other surgical complications after the initial telephone consultation, and although the patients were not reviewed face to face, given that our unit is one of the main eye units providing 24-hour emergency eye care within the greater London area, we would expect patients who developed any visual complications after their procedure to attend our hospital and be reviewed within the vitreoretinal unit. Notwithstanding the COVID-19 pandemic, the growing capacity issues within ophthalmic practice means that telemedicine platforms will become a key tool in delivering this care to a wider population in the future.⁴

S.M. Shahid, R. Anguita, L. daCruz

Moorfields Eye Hospital, London, United Kingdom.

Originally received Jul. 23, 2020. Final revision Nov. 15, 2020. Accepted Nov. 20, 2020.

Correspondence to:

Syed M. Shahid, FRCOphth: syed.shahid1@nhs.net.

References

1. World Health Organisation. Coronavirus disease (COVID-19) pandemic. 2020. www.who.int/emergencies/diseases/novel-coronavirus-2019. Accessed 11 May 2020.
2. Williams AM, Kalra G, Commiskey PW, et al. Ophthalmology practice during the coronavirus disease 2019 pandemic: the university of Pittsburgh experience in promoting clinic safety and embracing video visits. *Ophthalmol Ther* 2020;9:1–9.
3. Al-Abri R, Al-Balushi A. Patient satisfaction survey as a tool towards quality improvement. *Oman Med J* 2014;29:3–7.
4. Ting DS, Gunasekeran DV, Wickham L, Wong TY. Next generation telemedicine platforms to screen and triage. *Br J Ophthalmol* 2020;104:299–300.

Footnotes and Disclosure

The authors have no proprietary or commercial interest in any materials discussed in this article.

Acknowledgements: Hilary Newman, medical secretary, for conducting the telephone surveys.

Paracentral acute middle maculopathy following high-intensity interval training



High-intensity interval training (HIIT) is a cardiovascular exercise strategy that combines short bursts of intense anaerobic exercise with quick recovery periods. There are significant cardiovascular, metabolic, and mental health benefits associated with HIIT.¹ Furthermore, this exercise regimen is correlated with better macular and optic nerve head capillary perfusion, microvascular remodelling, and decreased size of the foveal avascular zone in the long-term.^{1,2}

Paracentral acute middle maculopathy (PAMM) is an optical coherence tomography (OCT) finding that may be found on its own as part of an ischemic infarct of the middle retinal layers, specifically, the inner nuclear layer (INL), which results in global flow impairment to the retinal capillary system, specifically at the level of intermediate and deep capillary plexuses (DCPs). PAMM most commonly occurs as a result of flow impairment in central retinal venous occlusion, central retinal artery occlusion, or branch retinal artery occlusion. Less commonly, it may occur secondary to an extrinsic

etiology such as medications, migraines, or a viral prodrome.³ Given the vastly improved multimodal imaging capacities in recent years, this entity is more frequently diagnosed in patients presenting with a paracentral scotoma.

Patients with isolated PAMM often describe central or cecentral scotomas(s) that may disappear within days to weeks. On fundus examination, there may be associated greyish lesions that are smoother and deeper than cotton wool spots (CWSs) and that correspond to an infarct in the middle and/or inner retinal layers within the macula. OCT imaging reveals pathognomonic placoid hyper-reflective bands at the level of the inner retinal layer (INL) and the inner plexiform layer.^{3,4} Near-infrared (NIR) imaging often shows characteristic hyporeflective areas in the perifoveal region. OCT angiography (OCTA) may demonstrate attenuation and a lower capillary density at the level of the intermediate capillary plexus and DCP.^{3–5} Furthermore, en-face OCT segmented at the level of the DCP is often useful in correlating the level of ischemia and characterizing the pattern of PAMM (i.e., perivenular, globular, or diffuse), which often correlate with the degree of ischemia.⁴

We describe, what is to our knowledge, the first report of a case of PAMM associated with HIIT exercise.

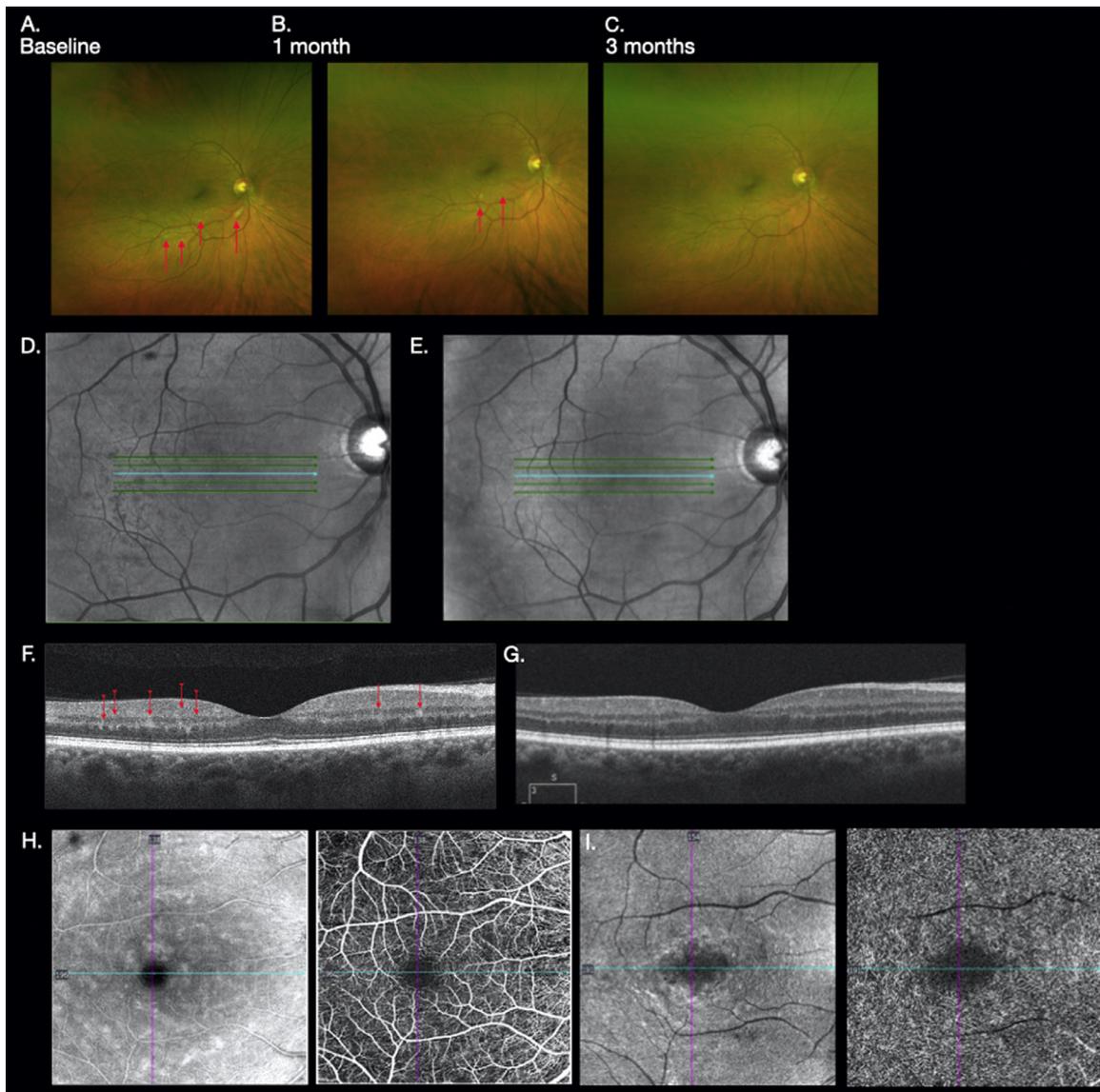


Fig. 1—Wide-field color fundus photograph at baseline demonstrating small perivenular cotton wool spots corresponding to superficial capillary ischemia (red arrows) (A), which were reduced in numbers by 1 month (B) and completely resolved by 3 months (C). Near infra-red (NIR) photograph of the right eye demonstrating intraretinal hyper-reflective lesions corresponding to areas of infarct at baseline (D), which mostly resolved by 1-month follow-up (E). Optical coherence tomography (OCT) of the right eye at baseline at the level of the hyporeflexive lesions on NIR demonstrating inner and middle retinal layer hyper-reflective bands corresponding to areas of middle and inner retinal infarct (red arrows) (F). These lesions had significantly resolved by 1-month follow-up (G). OCT angiography using Zeiss Cirrus HD-OCT 5000 (Carl Zeiss Meditec, Dublin, CA) demonstrating numerous small hyper-reflective lesions in the superficial (H: en-face, left, angioplex, right) and deep capillary plexus in a perivenular fern-like pattern (I: en-face, left, angioplex, right).

A 54-year-old Caucasian man presented to the retina clinic with 1-day history of bilateral negative scotomas that were more prominent in his right eye (OD). His symptoms started a few minutes after an intense 1-hour HIIT class at a local gym. He was diagnosed with borderline hypertension but was otherwise healthy with no history of medication or illicit drug use, and no family history of cardiovascular disease.

His best-corrected visual acuity (BCVA) was 20/20 in both eyes (OU). The intraocular pressure and anterior segment examination were within normal limits. Fundus examination revealed small CWSs within the inferior

arcade and blunting of the foveal reflex, OD (Fig. 1A). The left fundus examination was normal. NIR imaging revealed multiple tiny round hyporeflexive spots in perifoveal microcapillaries, OD (Fig. 1D). There were multiple inner retinal hyper-reflective bands on OCT imaging in that eye (Fig. 1F), consistent with a diagnosis of PAMM, that correlated with the hyporeflexive lesions on corresponding NIR.

En-face OCT revealed hyper-reflective lesions in the DCP corresponding to the inner plexiform layer/INL in a perivenular pattern, and OCTA demonstrated areas of

capillary dropout and nonperfusion (Fig. 1H, I) in the DCP. Intravenous fluorescein angiography was essentially normal.

The patient was observed and advised against further HIIT exercise. A metabolic work-up was negative. The CWSs were significantly reduced by 1 month (Fig. 1B) and were undetectable at 3-month follow-up (Fig. 1C). Similarly, the perifoveal inner retinal hyper-reflective PAMM lesions resolved at 1 month with residual thinning of the INL (Fig. 1E, F). At his 3-month follow-up, he reported no residual scotomas.

Bakhoun et al.⁴ have identified distinct patterns of PAMM correlating with severity of ischemia on en-face OCT segmentation of the INL. A “perivenular fern-like” PAMM pattern is associated with better final visual acuity, whereas a “diffuse globular hyper-reflective pattern or a pattern of ischemia involving both the middle and inner retinal layers” is reported to correlate with vision loss. We identified a similar perivenular PAMM pattern in our patients on en-face OCT segmented at the level of the INL (Fig. 1I). Indeed, several authors have found this pattern to correspond to non-ischemic central retinal venous occlusion or central retinal artery occlusion. It is notable that in our case, in the absence of a known retinal vascular disease, HIIT exercise resulted in this perivenular finding as an extrinsic inciting factor. We speculate that much like the mechanism of migraine-induced PAMM, HIIT exercise may have resulted in arterial vasospasm and retinal capillary infarcts in this case.

PAMM occurs most commonly in men with an average age of 59 years with underlying retinal vascular disease such as diabetes or hypertension.^{3,4} Subtle macular lesions, which were not clinically visible in our case, are believed to correspond to areas of deep capillary infarction and are often seen as wedge-shaped, oval, or petaloid hyporeflective lesions on NIR imaging. Our patient presented with visible CWSs near the arcades, which is consistent with multilevel retinal capillary ischemia, previously described.⁶ PAMM is often self-resolving without residual visual scotoma given that it spares the ellipsoid layer.³ Although the exact etiology of PAMM or PAMM-like lesions is not clear, in the absence of local retinal vascular disease such as a vascular occlusion, hypertensive retinopathy, or sickle cell or Purtscher’s retinopathy, extrinsic factors such as caffeine intake, amphetamines and vasopressors, significant blood loss, orbital compression, and viral prodromes have all been implicated.^{3,4}

There is no doubt that physical activity, including HIIT exercise, has significant cardiovascular benefits. Nevertheless, HIIT was reported to culminate in arteriolar vasospasm and transient vision loss in 2 prior case series.^{1,2} In the short-term, HIIT exercise has also been shown to significantly reduce perfusion of the optic nerve and the fovea on OCTA imaging immediately after HIIT exercise.² In the long-term, however, these effects often reverse in participants who performed HIIT over a 4-week period, resulting

in better microcapillary perfusion. On OCTA, prolonged HIIT has been found to alter retinal venular arteriolar diameter and reduce the size of the foveal avascular zone.^{1,2}

To our knowledge, this is the first ever report of PAMM following HIIT exercise. Given the subtlety of symptoms and findings on examination, this diagnosis should not be overlooked. Our patient had a BCVA of 20/20, but his multimodal imaging, including NIR, OCT, and OCTA had subtle changes to help make the correct diagnosis. These imaging modalities are invaluable in helping arrive at the correct diagnosis.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jcjo.2020.08.008.

Parnian Arjmand,*† Efreem D. Mandelcorn*†

*University Health Network, Toronto, Ont.; †University of Toronto, Toronto, Ont.

Originally received Apr. 20, 2020. Final revision Aug. 16, 2020. Accepted Aug. 29, 2020.

Correspondence to Parnian Arjmand. parnian.arjmand@mail.utoronto.ca.

References

1. Schmitz B, Nelis P, Rolfes F, et al. Effects of high-intensity interval training on optic nerve head and macular perfusion using optical coherence tomography angiography in healthy adults. *Atherosclerosis* 2018;274:8–15.
2. Alnawaiseh M, Lahme L, Treder M, Rosentreter A, Eter N. Short-term effects of exercise on optic nerve and macular perfusion measured by optical coherence tomography angiography. *Retina* 2017;37:1642–6.
3. Bakhoun MF, Freund KB, Dolz-marco R, et al. Paracentral acute middle maculopathy and the ischemic cascade associated with retinal vascular occlusion. *Am J Ophthalmol* 2018;195:143–53.
4. Rahimy E, Kuehlewein L, Sadda SR, Sarraf D. Paracentral acute middle maculopathy: what we knew then and what we know now. *Retina* 2015;35:1921–30.
5. Schwartz R, Hykin P, Sivaprasad S. Localization of paracentral acute middle maculopathy using optical coherence tomography angiography. *Ophthalmic Surg Lasers Imaging Retina* 2018;49:619–24.
6. Yu S, Pang CE, Gong Y, et al. The spectrum of superficial and deep capillary ischemia in retinal artery occlusion. *Am J Ophthalmol* 2015;159 53–63.e1–2.

Footnotes and Disclosure

The authors have no proprietary or commercial interest in any materials discussed in this article.