



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Seeking clarity on retinal findings in patients with COVID-19

Authors' reply

We are thankful for the comments in response to our Correspondence about retinal findings in patients with COVID-19.¹ COVID-19 is a challenging new disease that has raised many questions around unusual findings.

Regarding the comorbidities of the 12 patients,¹ seven patients had no comorbidities, one had controlled type 2 diabetes and high blood pressure, two had high blood pressure with good clinical control, one had a history of dyslipidaemia, and one had ankylosing spondylitis, controlled with adalimumab, and no previous history of ocular involvement.

A major concern raised was that the reported hyper-reflective lesions at the level of the ganglion cell and inner plexiform layers were, in fact, cuts through normal retinal blood vessels. To ensure that this was not the case, we excluded vertical optical coherence tomography (OCT) scans from our analysis and used only horizontal scans to avoid vessel crossings.

Since our original Correspondence,¹ we have examined more than 150 patients who tested positive for COVID-19 and whose disease ranged in severity, from asymptomatic to requiring admission to intensive care. We have refined our examination protocols. Using the B-scan flow overlay feature of OCT angiography, we found an absence of blood flow within the retinal lesions of many patients, differentiating these lesions from blood vessels with active blood flow. We observed similar findings outside of the posterior pole. Additionally, we have noticed fewer cotton wool spots and microhaemorrhages with time in these patients.

More than 6 months has passed since the outbreak of severe acute respiratory syndrome coronavirus 2, and lots

of new information has emerged describing COVID-19 pathophysiology. These retinal lesions appear to be part of a widespread, ischaemic, microvascular process, the effects of which have been reported in other parts of the body,²⁻⁵ as Pradeep Venkatesh suggested.

Following up these patients closely is essential, and we understand the urgency of finding answers but also agree with the necessity for caution when interpreting new information. We intended our Correspondence to call attention to the need for careful evaluation of the fundus because therein lies a unique opportunity to analyse the body's microvasculature in vivo. We are collecting more information and intend to describe these in the medical literature in due course.

We declare no competing interests.

*Paula M Marinho, *Heloisa Nascimento, Alexya A A Marcos, André C Romano, Rubens Belfort Jr*
helomn@gmail.com

Department of Ophthalmology, Instituto Paulista de Estudos e Pesquisas em Oftalmologia, IPEPO, Instituto da Visão, São Paulo, Brazil; and Ophthalmology Department, Hospital São Paulo, Federal University of São Paulo, São Paulo 04023-062, Brazil

- 1 Marinho PM, Marcos AAA, Romano AC, Nascimento H, Belfort Jr R. Retinal findings in patients with COVID-19. *Lancet* 2020; **395**: 1610.
- 2 Danzi GB, Loffi M, Galeazzi G, Gherbesi E. Acute pulmonary embolism and COVID-19 pneumonia: a random association? *Eur Heart J* 2020; **41**: 1858.
- 3 Iba T, Levy JH, Levi M, Connors JM, Thachil J. Coagulopathy of coronavirus disease 2019. *Crit Care Med* 2020; published online May 27. <https://doi.org/10.1097/CCM.0000000000004458>.
- 4 Varga Z, Flammer AJ, Steiger P, et al. Endothelial cell infection and endotheliitis in COVID-19. *Lancet* 2020; **395**: 1417-18.
- 5 Yin S, Huang M, Li D, Tang N. Difference of coagulation features between severe pneumonia induced by SARS-CoV2 and non-SARS-CoV2. *J Thromb Thrombolysis* 2020; published online April 3. <https://doi.org/10.1007/s11239-020-02105-8>.

Submissions should be made via our electronic submission system at <http://ees.elsevier.com/thelancet/>