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.

overlying pigmented layer. This may explain the propensity for non-neovascular fluid, AVLs, and apertures to develop at the apex of a large drusenoid PED. The presence of AVL alone, however, is a sign of RPE impairment and a risk factor for the development of RPE aperture and/or atrophy.

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Papilledema associated with COVID-19 multisystem inflammatory syndrome in children

Multisystem inflammatory syndrome in children (MIS-C), also called *pediatric inflammatory multisystem syndrome*, is characterized by a wide range of symptoms and can present a diagnostic challenge given its myriad presentations. On top of the more well-known inflammatory manifestations of MIS-C, recent reports have also surfaced of MIS-C causing increased intracranial pressure.[1,2] MIS-C can present similarly to other systemic inflammatory disorders such as Kawasaki disease and can be especially difficult to distinguish from Kawasaki disease if a Kawasaki-like presentation is accompanied by a positive test for coronavirus disease 2019 (COVID-19).[3]

In adults, ocular manifestations of COVID-19 include nonspecific symptoms such as conjunctival hyperemia, chemosis, epiphora, and increased secretions.[4] However, there is a relative paucity of literature regarding ocular manifestations of COVID-19 in children relative to adults. Some documented pediatric symptoms include a similar conjunctivitis presentation, along with increased conjunctival discharge, ocular pain, and eyelid swelling,[5] but pediatric MIS-C is far from completely characterized.

Here we present a pediatric patient who developed bilateral papilledema and abducens nerve palsy in the setting of MIS-C to highlight the potential increased intracranial hypertension and neurologic complications of this inflammatory condition. Institutional review board approval was obtained at the Washington University in St. Louis, and consent was provided by the patient's parents.

A 12-year-old boy with no past medical history and a past ocular history of myopia, astigmatism, and mild amblyopia OD presented to our institution in May 2020 with fever, vomiting, and diarrhea. These symptoms were accompanied by headache, fatigue, dysgeusia, photophobia, and 2 episodes of epistaxis on the day of presentation. The patient's father had experienced similar symptoms and anosmia following recent domestic travel but was not tested for COVID-19. The patient did not have any respiratory or ophthalmic symptoms at presentation. Rapid streptococcal antigen and COVID-19 reverse transcription polymerase chain reaction tests were performed, both of which were negative, and the patient was discharged home. The patient returned 3 days later for persistent intermittent fever and diarrhea and was admitted. An infectious disease panel was notable for positive severe acute respiratory syndrome coronavirus 2 IgG.

Erythrocyte sedimentation rate and C-reactive protein were elevated at 30 mm/h and 325.0 mg/L, respectively. Complete blood count was notable for reduced hemoglobin (12.0 g/dL), hematocrit (35.4%), and platelets (57,000/μL). During his hospital stay, the patient developed shock, hypotension, hypercoagulability, hyponatremia, acute kidney failure, and acute respiratory failure. An electrocardiogram showed first-degree atrioventricular block, and repeat echocardiograms showed coronary artery dilation and systolic dysfunction indicative of myocarditis. The patient was diagnosed with MIS-C and managed with intravenous immunoglobulin, intravenous hydrocortisone, and enoxaparin.

One week into admission, the patient complained of intermittent episodes of headache accompanied by bilateral blurred vision and binocular diplopia. On ophthalmologic examination, his best-corrected near visual acuity was 20/20-2 OD and 20/20 OS. Colour vision on Ishihara testing and intraocular pressures were normal. There was no afferent pupillary defect. Slit-lamp examination of the anterior segment was normal. Fundus examination revealed bilateral grade II–III papilledema (Fig. 1) with elevation of the optic nerve heads and peripapillary retinal nerve fibre layer and tortuosity of the retinal vasculature. Extraocular motility examination demonstrated a right esotropia of 15 prism diopters and a −0.5 abduction deficit of the right eye consistent with a right abducens nerve palsy, likely secondary to increased intracranial pressure. Magnetic resonance imaging and magnetic resonance venogram of the head were negative for dural venous sinus thrombosis, though a suspected congenitally hypoplastic left transverse venous sinus was noted (Fig. 2). A lumbar puncture was not performed because the patient's clinical symptoms were improving and his concurrent intravenous immunoglobulin therapy might confound the cell count, IgG index, and opening pressure results. The patient's blurry vision and diplopia resolved during his hospital course, so observation was recommended. He was discharged 12 days after admission with continuing treatment on acetaminophen, clopidogrel, Aspirin, and lisinopril.

Outpatient ophthalmology follow-up at 1.5 months revealed a best-corrected distance visual acuity of 20/25 OD and 20/20 OS with complete resolution of the bilateral papilledema and right abducens nerve palsy. The patient denied any further episodes of diplopia after discharge. He is scheduled to return in 6 months for follow-up.

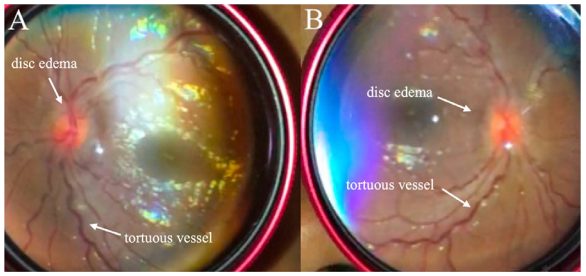

Fig. 1—Fundoscopic examination of (A) right eye and (B) left eye. Optic discs show swelling consistent with bilateral grade II–III papilledema, in addition to elevation of the optic nerve heads and peripapillary retinal nerve fibre layer and retinal vessel tortuosity.

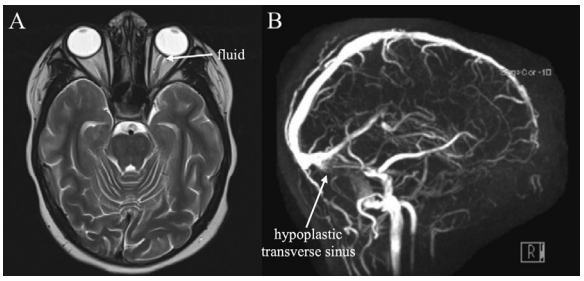

Fig. 2—Magnetic resonance imaging (A) and magnetic resonance venography (B). (A) Fluid along optic nerve sheath suggests increased intracranial pressure correlating with the patient's papilledema. (B) Transverse sinus appears hypoplastic without dural venous sinus thrombosis.

In this report, we describe a pediatric patient presenting with bilateral optic nerve edema and a concurrent right abducens nerve palsy related to increased intracranial pressure in the setting of COVID-19-associated Kawasaki-like inflammation, MIS-C. Whereas previous studies have focused on the more anterior ocular manifestations of COVID-19 in adults[4] and children,[5] this case demonstrates neurologic complications of COVID-19-associated MIS-C. This case is, to the best of our knowledge, only the third reported with elevated intracranial pressure and papilledema with abducens nerve palsy[1,2] and the first to include fundus images.

Though the precise etiology of the increased intracranial pressure remains unclear, it is likely to be a contributing factor to the ocular and neurologic deficits observed in this MIS-C patient. Lumbar puncture was not attained and elevated opening pressure could not be confirmed because of the confounding impact of the patient's immunoglobulin therapy and the resolution of his symptoms. However, the patient's constellation of papilledema, abducens nerve palsy, and headaches is consistent with literature reports of elevated intracranial pressure in patients with MIS-C.

Familiarity with MIS-C ocular presentations can better inform patient care as the COVID-19 pandemic continues to spread at an alarming pace among the pediatric population. Awareness of the ocular and neurologic manifestations of MIS-C is important in recognizing the syndrome quickly, and neurologic complaints of visual disturbances, headache, and ocular movement abnormality should raise suspicion for increased intracranial pressure and possible MIS-C. In patients with these symptoms, a dilated fundus examination may be of benefit.

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Delayed diagnosis of autosomal dominant optic atrophy until seventh decade of life

Autosomal dominant optic atrophy (ADOA) is the most common hereditary optic neuropathy, manifesting in approximately 1 in 50 000 people, and up to 1 in 10 000 in Denmark, owing to a founder mutation.[1] Isolated ADOA typically manifests in the first 2 decades of life as bilateral painless progressive vision loss and is therefore mostly diagnosed in childhood to young adulthood. We present a series of 2 older patients, aged 63 and 64 years, who had delayed ADOA diagnosis as proband patients in their families, emphasizing the point that chronological age should not be the sole determining factor for ordering testing for ADOA in cases of unexplained optic neuropathy.

Patient 1, a 64-year-old Caucasian man, was referred to the neuro-ophthalmology clinic with a 12-year history of isolated, unexplained bilateral painless progressive central vision loss. His past medical history was significant for type II diabetes mellitus, hyperlipidemia, obesity, obstructive sleep apnea, and ocular hypertension. His regular medications were Aspirin, atorvastatin, fenofibrate, metformin, montelukast, omeprazole, latanoprost, and sertraline. He did not smoke cigarettes or drink alcohol and reported a balanced diet. His family history was significant for an 11-year-old granddaughter who had recently been diagnosed with optic nerve hypoplasia.

The patient initially presented with painless bilateral slowly progressive vision loss 12 years prior. An initial diagnosis of cataracts was made with visual acuity of 20/100 OD and 20/80 OS and an otherwise normal eye examination. He underwent bilateral cataract extraction and intraocular lens implantation without improvement. Subsequent evaluation revealed an elevated intraocular pressure of up to 25 mm Hg, gonioscopy showing Shaffer grade 4 open angles, a cup-to-disc ratio of 0.3, and otherwise normal optic discs OU. He was treated with latanoprost for presumed glaucoma. In total, he saw 4 different ophthalmologists over 12 years. Optic atrophy was noted only in the records, 10 years after symptom onset, but it is likely that this ophthalmoscopic finding was present earlier in the course. The patient was referred to neuro-ophthalmology 12 years after initial presentation because the optic disc did not appear to be typically glaucomatous and because of central vision loss.

On neuro-ophthalmologic examination, the patient's visual acuity was 20/40 OU. His pupils were isocoric without a relative afferent pupillary defect. Colour vision on Ishihara testing was 14/14 OU. Intraocular pressures were 17mm Hg OD and 19mm Hg OS. Dilated fundus examination showed optic disc pallor temporally OU, with a cup-to-disc ratio of 0.5 OD and 0.4 OS. The remainder of the eye and neurologic examinations was normal. Automated perimetry (Humphrey visual field 24-2) showed an enlarged blind spot and superior paracentral visual field defect, with a mean deviation of −3.55dB OS, and a temporal visual field defect superiorly, with a mean deviation of −3.53dB OD. Optical coherence tomography (OCT) showed average retinal nerve fibre layer (RNFL) of 64μm OD and 65μm OS, with primarily papillomacular bundle loss OU (Fig. 1). The OCT macular ganglion cell layer showed diffuse thinning.

The work-up for optic atrophy included magnetic resonance imaging of the brain and orbits with contrast material and was unremarkable. Laboratory studies, including complete blood count; determinations of sedimentation rate and C-reactive protein, folate, and angiotensin-converting enzyme levels; syphilis serology; and myelin oligodendrocyte glycoprotein testing, were unremarkable. Serum homocysteine was elevated at 14.9 μmol/L (normal <11.4 μmol/L), and the patient's B_{12} level was low normal at 366 pg/mL (normal, 200−1100 pg/mL). Genetic testing revealed a pathogenic heterozygous frameshift mutation in the *PA1* gene, with a c.2708_2711:4 base pair deletion at codons 903−904. The diagnosis of ADOA was made, and the patient's granddaughter with previously known optic nerve head abnormalities was also confirmed to have the same genetic diagnosis. Further family genetic counselling was recommended.