Review Article

Multi-color imaging in a unilateral central retinal artery occlusion following dengue fever: A case report and literature review

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ABSTRACT

Background: Dengue fever is associated with various sight-threatening ocular manifestations, some of which can occur several months after fever. These include subconjunctival hemorrhage, vitreous hemorrhage, retinal hemorrhage, cotton wool spots, central and branch retinal artery occlusion, central scotoma, papilledema, optic neuropathy, retinal vasculitis, retinitis, retinal pigment epithelium mottling, foveolitis, choroidal effusion, exudative retinal detachment, anterior uveitis, endogenous endophthalmitis, and panophthalmitis. Herein, we report a patient with unilateral central retinal artery occlusion (CRAO) and raised dengue immunoglobulin G (IgG) titers who underwent serial multimodal imaging with fundus photography, spectral domain optical coherence tomography (SD-OCT), optical coherence tomography angiography (OCTA), and multi-color imaging (MCI). Furthermore, we reviewed recent publications highlighting different eye diseases and the role of MCI in their diagnosis and serial monitoring.

Case presentation: A 53-year-old Asian Indian woman complained of blurring of vision in the right eye (OD) two months after a bout of fever. Her best-corrected distance visual acuity was finger counting close to the face in the OD and 20/40 in the left eye. CRAO of the OD was diagnosed. Systemic investigations were normal except for elevated dengue IgG levels. Optical coherence tomography and fluorescein angiography confirmed this diagnosis. MCI and SD-OCT using Spectralis™ performed before and after treatment with oral steroids demonstrated improvement. MCI served as a noninvasive ancillary tool for monitoring the CRAO. In addition to the case report, we summarize articles pertaining to MCI published during the years 2018–2022. The list is not exhaustive but highlights salient features of different retinal and choroidal disorders evaluated using MCI. Our summary highlights the role of MCI in the diagnosis and serial monitoring of eye diseases.

Conclusions: A diagnosis of post-dengue fever retinal artery occlusion should be made after ruling out other causes of retinal artery vascular occlusion. We demonstrated retinal changes using serial imaging. MCI can be a useful tool, along with SD-OCT, to monitor clinical improvement. Optometrists can follow up patients with retinal vascular occlusions using noninvasive methods.

KEYWORDS

dengue fever, retinal artery occlusion, multimodal imaging, multi-color imaging, follow-up monitoring, optometrist

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INTRODUCTION

Dengue fever (DF) is associated with various ocular manifestations, some of which are sight threatening. Ocular manifestations can occur many months after fever [1-5] and include subconjunctival hemorrhage, vitreous hemorrhage, retinal hemorrhage, cotton wool spots, central and branch retinal artery occlusion, central scotoma, papilledema, optic neuropathy, retinal vasculitis, retinitis, retinal pigment epithelium mottling, foveolitis, choroidal effusion, exudative retinal detachment, anterior uveitis, endogenous endophthalmitis, and panophthalmitis [1-7]. After fever, there may be retinal angiogenesis in the periphery or choroidal neovascularization in the macula, which is very rare [8].

Multi-color imaging (MCI) is a proprietary technology of Spectralis™ (Heidelberg Engineering™, Germany), which manufactures SD-OCT [9]. In this method, multicolor images are captured using three wavelengths that penetrate different depths into the retina. Spectralis™ scans the retina at three laser wavelengths: blue (486 nm), green (518 nm), and near-infrared (815 nm). A pseudocolor image is obtained by combining all three wavelengths. The three monochromatic images are used to visualize specific layers of the retina and choroid. Each laser is designed for a specific purpose; the blue laser evaluates pathology of the superficial retina and vitreoretinal interface such as epiretinal membranes, retinal nerve fiber layer thinning, and macular pigment changes, while the green laser evaluates vascular details and surface retinal diseases, as well as intra-retinal lipid exudation [10]. The near-infrared laser penetrates deeper into the retina due to its longer wavelength, allowing better imaging of the outer retina, retinal pigment epithelium, and choroid, including drusen and retinal pigmentary epithelium alterations [11, 12]. The images obtained using the multicolor system are pseudo-colored and, in most cases, resemble clinical fundus images. MCI has many clinical applications, and in some cases, it may replace conventional color fundus photography [13]. When adapting to MCI, practitioners should be aware of differences in the appearance of pathological changes and artifacts [14].

We present a unique case of post-dengue fever central retinal artery occlusion (CRAO) with permanent visual impairment evaluated using serial multimodal imaging, including fundus photography, spectral domain optical coherence tomography (SD-OCT), and MCI. In this article, we review the role of MCI among other imaging modalities by assessing studies published during the years 2018–2022.

CASE PRESENTATION

A 53-year-old Asian Indian woman was hospitalized in her hometown for high fever, myalgia, arthralgia, and ocular pain. She was diagnosed with a nonspecific viral infection and recovered completely. The details of the investigations and treatment during that period were not available. Two months later, during the convalescent phase, the patient noticed blurred vision in the right eye (OD). She presented to us one week after the onset of ocular symptoms. Detailed information regarding diabetes mellitus, blood pressure, fever, joint pain, skin disorders, increased cholesterol, and heart problems was asked, which was unremarkable.

Best-corrected distance visual acuity (BCDVA) was finger counting close to the face in the OD and 20/40 in the left eye (OS) (UniSys – Pro Professional Visual Refraction System, Jutron Vision, Baroda, India). On slit-lamp examination (Labomed™, Gurgaon, India), the anterior segment was unremarkable in both eyes except for the nasal pterygium in the OS. Fundus examination using a slit lamp with the 90-D lens (VOLK Optical, Mentor, USA), and a binocular indirect ophthalmoscope (Appasamy AAIO wireless; Appasamy Associates, Chennai, India) with the 20-D lens (VOLK), showed a macular cherry-red spot in the OD (Figure 1A). Findings in the OS were normal.

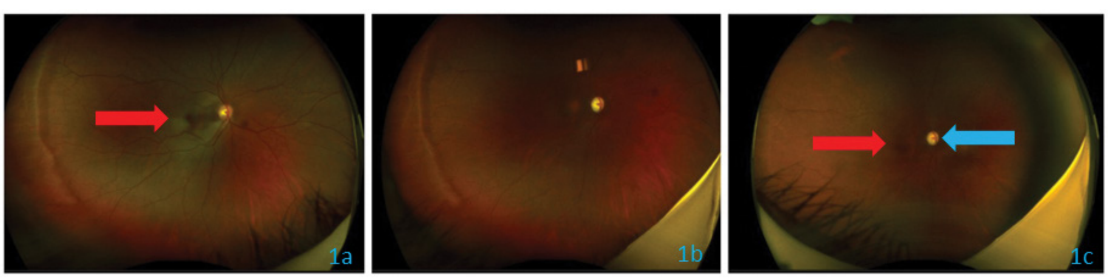

Figure 1. Wide field color fundus imaging of the right eye. (A) Image showed a "cherry-red spot" surrounded by pale edematous macula (red arrow). (B) Four weeks later, image showed disappearance of the cherry-red spot and the optic disc becoming pale. (C) Ten weeks later, the macula had a mottled appearance (red arrow) and the optic disc was pale (blue arrow).

SD-OCT with Spectralis™ (Heidelberg Engineering™, Inc., Heidelberg, Germany) revealed hyperreflective inner retinal layers with retinal thinning nasal to the fovea, with cystoid changes in the OD (Figure 2A). Findings in the OS were normal.

Fundus fluorescein angiography (FFA) with Spectralis™ showed an arm-to-retina time of 15 s. There was a slight delay in filling of the retinal vessels. There was no evidence of vasculitic leakage or disc staining in the OD. Findings in the OS were normal (Figure 3A-F, OD) (Figure 3G, OS).

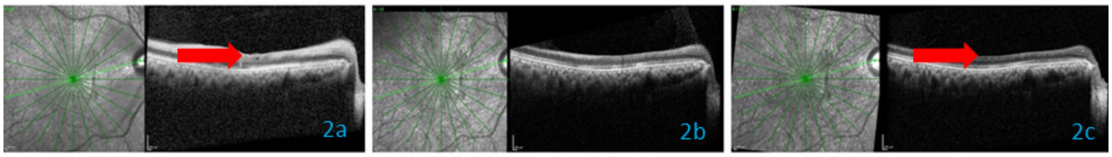

Figure 2. Spectral domain ocular coherence tomography (SD-OCT) of the right eye. (A) Hyperreflective inner retinal layers with retinal thinning nasal to the fovea with cystoid changes in the right eye (red arrow). (B) Four weeks later, images showed reduced hyper-reflectivity in the inner layers associated with thinning of the retinal layers. (C) Ten weeks later, images showed thinning of the retinal layers.

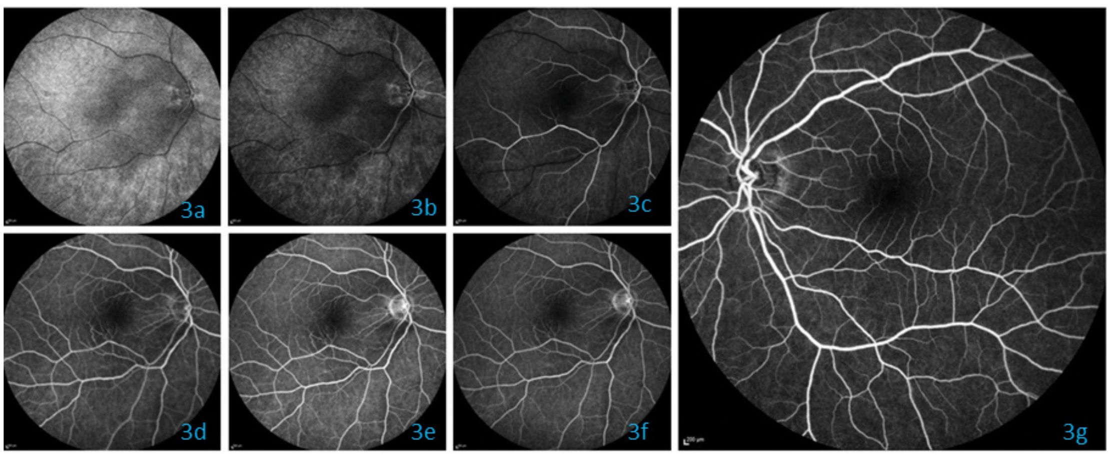

Figure 3. Fundus fluorescein angiography (FFA). The right eye (A-F) in the early, mid, and late phases as the dye passes through the arterial and venous circulation. The ciliary artery was not visible in the early phases. There was a slight delay in filling of the retinal vessels. In the right eye, there was no evidence of a vasculitic leak or disc staining, and a mild leak was seen temporally (A-F). FFA of the left eye was normal (G).

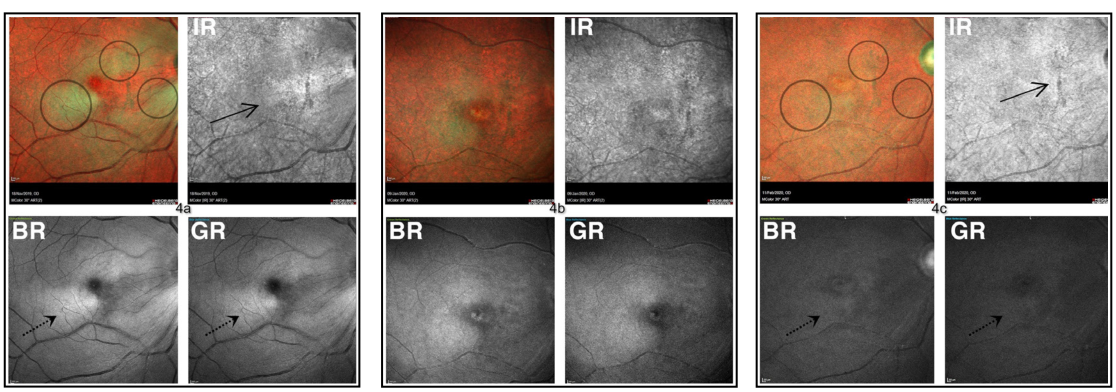

Figure 4. Multi-color imaging (MCI) of the right eye with Spectralis™ (Heidelberg Engineering™, Germany): (A) Images at presentation show whitening in the macular area with sparing of the cilio-retinal artery zone in blue and green reflectance (BR and GR) (black broken arrow) indicating swelling, with hyperreflective areas in infrared reflectance (IR) (solid black arrow). Retinal edema causes absorption of the infrared wavelength and increased reflection of the medium wavelength (GR). The composite image appears green (black circles) due to the infarcted retinal areas. (B) One month after initiation and tapering of oral steroids, BR and GR show reduced whitening and IR shows stippled hyper- and hyporeflective areas. (C) At the final visit (10 weeks after presentation), BR and GR show loss of nerve fiber layer pattern with hyporeflective areas representing the perfused areas. The green color in the composite image has disappeared.

MCI of the OD with Spectralis™ (Figure 4A) showed whitening of the retina in the pseudocolor/composite image, with a cherry-red spot and peripapillary sparing in the area of ciliary artery perfusion.

Optical coherence tomography angiography (OCTA) with a spectral domain (SD) OCTA system (AngioVue—OptoVue, Inc., Fremont, CA, USA) using the Split Spectrum Amplitude Decorrelation Angiography (SSADA) algorithm was used by a single trained operator to evaluate the vascular structure, the foveal avascular zone, and the superficial and deep retinal vascular plexus densities. However, this did not reveal any useful information due to projection artifacts at presentation. The images were not included in this report as they had artifacts due to fixation loss and poor centration.

Systemic investigations such as C-reactive protein level, *Treponema pallidum* hemagglutination, human immunodeficiency virus I and II, anti-hepatitis C virus antibodies, anti-nuclear antibody (ANA), anti-neutrophil cytoplasmic antibody (ANCA), serum homocysteine level, fasting and postprandial blood glucose level, lipid profile, complete blood count with peripheral blood smear, erythrocyte sedimentation rate (ESR), and detailed cardiac, hematological, and carotid evaluation, including echocardiography, were normal. A carotid Doppler study revealed medial wall thickening of the carotid system, which was deemed non-significant by the cardiologist. Mantoux, Chikungunya immunoglobulin (Ig)G/IgM, Widal test, Weil–Felix test, and dengue NS 1 antigen/IgM were negative. Dengue Immunoglobulin G (IgG) (2.2) by enzyme-linked immunosorbent assay (ELISA) was the only positive test result. The IgG/IgM ratio in our case was 7.69, indicating a subacute dengue infection. Urine analysis showed 20–25 white blood cells/high power field. Urine culture was not performed, as her repeat urine testing a week later showed fewer white cells (2-4/high power field). The urine contained 1+ protein, which was deemed insignificant by the cardiologist. Nitrofurantoin 100 mg twice daily was administered for 7 days, followed by deflazacort 36 mg per day after clearance from the cardiologist, who was evaluating her systemically. Deflazacort was tapered over six weeks, with a reduction of 6 mg every week.

Table 1. Clinical course of the current patient, along with investigation results

Investigation	Initial Presentation	At four weeks of follow-up	At ten weeks of follow-up
BCDVA	**OD:** Finger counting close to the face. **OS:** 20/40	**OD:**20/500 **OS:**20/32	**OD:** 20/320 **OS:**20/25
RAPD	**OD:** present **OS:** -	**OD:** present **OS:** -	**OD:** present **OS:** -
Anterior segment examination	**OD:** AC Quiet **OS:** Nasal pterygium	**OD:** AC Quiet **OS:** Nasal pterygium	**OD:** AC Quiet **OS:** Nasal pterygium
Fundus examination	**OD:** CRAO with cilioretinal sparing. **OS:** Foveal reflex was dull, and CDR was 0.50.	**OD:** CRAO with cilioretinal sparing, CDR 0.60, and temporal pallor of optic disc. **OS:** Foveal reflex was dull, and CDR was 0.50.	**OD:** CRAO with cilioretinal sparing, CDR 0.60, and pallor of optic disc. **OS:** Foveal reflex was dull, and CDR was 0.50.
SD-OCT imaging	**OD:** Inner retinal swelling with cystoid changes with thinned-out retina nasally. **OS:** Normal	**OD:** Thinning of the inner retinal layers, and no cystoid changes. **OS:** Normal	**OD:** Thinning of the inner retinal layers, and no cystoid changes. **OS:** Normal
OCTA imaging*	**OD:** Projection/motion artifacts in the superficial and deep capillary plexus. **OS:** Normal	**OD:** Reduced projection artifacts. **OS:** Normal	**OD:** N/A **OS:** N/A
FFA	**OD:** Arm retina time of 15 seconds with no disc staining. **OS:** Peripheral sheathing and leakage.	**OD:** peripheral leakage. **OS:** peripheral leakage.	**OD:** N/A **OS:** N/A
Multi-color imaging	**OD:** Whitening in the macular area, sparing the cilio-retinal artery zone in BR and GR indicative of swelling, and hyperreflective areas in IR. **OS:** Normal	**OD:** BR and GR show reduced whitening, and IR shows stippled hyperreflective and hyporeflective areas. **OS:** Normal	**OD:** The disappearance of the retinal whitening in the pseudocolor image and BR/GR showed a loss of NFL pattern architecture. **OS:** Normal

Abbreviations: BCDVA, best-corrected distance visual acuity; OD, right eye; OS, left eye; RAPD, relative afferent pupillary defect; AC, anterior chamber; CRAO, central retinal artery occlusion; CDR, cup-to-disc ratio; SD-OCT, spectral domain optical coherence tomography; OCTA, optical coherence tomography angiography; N/A, not available; FFA, fundus fluorescein angiography; BR and GR, the blue and green reflectance; IR, infrared reflectance; NFL, nerve fiber layer.*Note: The OCTA images were not included in this report as they had artifacts due to fixation loss and poor centration.

Table 2. Summary of multi-color imaging articles published over the last four years

First Author (Year of Publishing)	Type	Participants	Observations on MCI	Advantage of MCI
Sanjay et al (2022) [19]	Case report	Unilateral recurrent CSCR following COVID-19 vaccine (COVISHIELD)	**Acute phase:** - A well-defined round greenish area was observed. - Greyish halo around the fovea was noted in BR and GR with the presence of a bright refractile dendritic pattern. - IR defined the halo and was better in suggesting a deeper pathology. **Resolution phase:** - Greenish halo around the fovea became less evident. - The disappearance of the refractile dendritic pattern and the IR image showed a whitish granular appearance around the fovea suggestive of RPE abnormalities.	MCI can be used to define the extent of involvement of different layers as well as monitor changes over time.
Gadde et al. (2022) [20]	Retrospective	Diabetic TRD	- Better visualization of the attachments and traction points of the posterior hyaloid face and pre-retinal membranes, which was comparable to the SD-OCT B-scan images. - IR had a poor agreement while GR and BR had a moderate agreement. - Composite MCI and GR images also had a comparatively higher intraclass coefficient when compared to CFP and IR images.	More sensitive for determining the extent of TRDs and detection of secondary membranes when compared to CFP, thus, aiding in better surgical planning.
Bair et al. (2022) [21]	Case report	Urticarial vasculitis with recurrent BRAO	- Greenish-tinged occlusive lesions were noted on MCI with high resolution and contrast.	Better for detection of retinal vascular occlusive disease.
Sanjay et al. (2022) [22]	Case report	Bilateral sequential acute macular neuroretinopathy in an Asian Indian female with β Thalassemia trait following COVID-19 vaccination and probable recent COVID infection-multimodal imaging study	- The normal bright halo during acute stage on the MCI images was lost. It only restored to normal at resolution. - The hyporeflectivity seen on OCTA can be correlated with changes in the MCI reflectivity.	Can detect early and subtle microvascular changes due to AMN.
Gupta et al. (2022) [23]	Prospective observational	Posterior uveitis	- CFP and clinical examination are more accurate than MCI in detecting retinochoroiditis and intraretinal hemorrhage.	Better for detecting lesions at the vitreoretinal interface.
Sanjay et al. (2021) [24]	Retrospective case series	PFR involving posterior pole	- The retinitis lesion appeared bright white on MCI, mainly on BR and GR images during the active stages of PFR. - Lesion appeared dull-grey to greyish white during the resolving stages and as dull-green in resolved cases. - Presence of intraretinal/subretinal fluid appeared as green color on MC images and less green than normal during the resolving stages. - Hex were seen as bright yellow- or orange-colored spots on MCI during the resolving stages of the disease.	Helpful for differentiation of activity in PFR.

Continued Table 2. Summary of multi-color imaging articles published over the last four years

First Author (Year of Publishing)	Type	Participants	Observations on MCI	Advantage of MCI
Kumar et al. (2021) [25]	Case-control	Eyes with post-operative metamorphopsia following RRD repair	- MCI and OCT were able to detect subclinical ERM, but there was no statistically significant difference between the groups.	Able to detect subclinical ERM.
Gong et al. (2021) [26]	Observational	DME with Hex	- Total area of Hex was larger by MCI than by CFP. - Distance between Hex and fovea was less by MCI than by CFP. - Percentage of Hex involving central macula in MCI was more than in CFP. - Hex involving central macula were positively associated with triglyceride and low-density lipoprotein.	Superior to CFP in detecting Hex and analysis of associations between Hex and serum lipid levels in DME.
Venkatesh et al. (2020) [27]	Retrospective observational	Type 2 Macular Telangiectasia	- Loss of transparency is better identified in BR than in CFP. - Superficial retinal crystals, branched right angled venule, RPE hyperplasia, and plaques were seen equally well with CFP. - Confocal IR images were better at detecting subretinal neovascularisation compared to CFP and FFA.	Better detecting certain features in Macular Telangiectasia type 2 vrsus CFP and FFA.
Govindahari et al. (2020) [33]	Retrospective	Type 2 Macular Telangiectasia	- Retinal crystals were recognized on MCI but not on FAF images. - Neurosensory retinal atrophy and subretinal neovascular membranes were detected using MCI. - Intraretinal pigmented hyperplasia was more accurately detected compared with RPE atrophy on MCI. - MCI showed a larger area of involvement, a higher number of quadrants involved, and better delineation of margins compared with FAF. - A higher mean number of vessel dipping foci was seen on MCI versus FAF.	Better at finding certain features in Macular Telangiectasia type 2 against FAF in detecting en face and cross-sectional features.
Venkatesh et al. (2020) [29]	Retrospective, descriptive	Choroidal Nevus	- MCI detected choroidal nevus only in 6 out of 12 eyes, possibly due to variability in melanin content. - IR showed mixed hypo- and hyper-reflectance pattern in one subject.	Variability in the melanin content of choroidal nevus can be studied using MCI.
Saurabh et al. (2020) [30]	Retrospective, observational	CSCR	- MCI detected SRF, PED, and RPE atrophy in more eyes than CFP. - MCI and CFP were inferior to gold standard method for detecting the above findings.	MCI is a more valuable imaging modality than CFP.
Bhattacharya et al. (2020) [31]	Pilot study	Myelinated nerve fiber layer	- MCI and IR were superior to CFP in delineating disc margins.	MCI and IR were superior to CFP in delineating disc margins.
Saurabh et al. (2020) [32]	Retrospective review	DME with CFT > 250 microns	- Location of cysts detected on OCT and MCI corresponded with that on FAF.	Superior to CFP in detecting DME cysts at the fovea.
Govindahari et al. (2019) [28]	A qualitative and quantitative comparison	CSCR	- MCI showed a higher mean cumulative area of RPE atrophic patches, NSD, and PED. - MCI demonstrated better-defined lesions (NSD, PED, and RPE atrophy) and more number of eyes with PED and pachyvessels compared with FAF.	MCI could document and monitor various structural changes in eyes with CSCR.

Continued Table 2. Summary of multi-color imaging articles published over the last four years

First Author (Year of Publishing)	Type	Participants	Observations on MCI	Advantage of MCI
Roy et al. (2019) [34]	Retrospective review	Diabetic retinopathy	- Hex were picked up most in GR images. - CWS were picked up in both GR and BR imaging, more than in CFP. - Retinal hemorrhages were picked up in GR images more than in CFP.	Hex, CWS, and hemorrhages were seen better in GR compared to CFP, BR, and IR, respectively.
Saurabh et al. (2018) [35]	Case report	Pigmented choroidal nevus	- Nevus appeared orange-red on MCI, and its size appeared larger than measured on the CFP image. - Being high in melanin content, pigmented choroidal nevus appeared hyperautofluorescent on the NIR-AF image. It was not picked up by lipofuscin-based blue autofluorescence.	This study described unreported imaging signatures of the pigmented choroidal nevus seen on MCI.
Basu et al. (2018) [36]	Retrospective	Glaucoma	- The RNFLD is better seen on GR and BR images versus a conventional red-free photograph. - IR image, which conveys information from a deeper RPE level, shows no abnormality.	GR and BR provide excellent imaging of RNFLD in patients with glaucoma, better than the CFP.
Muftuoglu et al. (2018) [37]	Retrospective	Eyes with choroidal melanoma, choroidal nevus, choroidal hemangioma, and CHRPE	- Amelanotic lesions appeared green on MCI due to lack of IR. - Pigmented lesions appeared red on MCI due to increased IR by melanin. - MCI underestimated the extent of the choroidal lesion by 33%.	Can detect characteristics of choroidal and retinal pigmentary lesions (border, halo, and drusen).
Kilic Muftuoglu et al. (2018) [38]	Retrospective	ERM	- The number of surface folds detected per quadrant was significantly higher in MCI than in CFP. - The ERM was better visualized on MCI than on CFP. - CFP failed to detect ERM when the mean central retinal thickness was < 413 microns. - GR provided better detection of surface folds than BR or IR.	MCI is superior in detecting ERM and delineating surface folds than CFP.

Abbreviations: Type, type of included study; MCI, multi-color imaging; COVID-19, Coronavirus disease; CSCR, central serous chorioretinopathy; GR, green reflectance; BR, blue reflectance; IR, infrared reflectance; RPE, retinal pigment epithelium; TRD, tractional retinal detachment; SD-OCT, spectral domain optical coherence tomography; CFP, color fundus photograph; BRAO, branch retinal artery occlusion; OCTA, optical coherence tomography angiography; AMN, acute macular neuroretinopathy; PFR, post-fever retinitis; Hex, hard exudates; RRD, rhegmatogenous retinal detachment; ERM, epiretinal membrane; DME, diabetic macular edema; FFA, fundus fluorescein angiography; FAF, fundus autofluorescence; SRF, subretinal fluid; PED, pigment epithelial detachment; CFT, central foveal thickness; NSD, neurosensory detachments; CWS, cotton wool spots; NIR-AF, near-infrared- autofluorescence; RNFLD, retinal nerve fiber layer defect; CHRPE, congenital hypertrophy of the retinal pigment epithelium.

Refractive correction of the OS did not initially improve because her nasal pterygium was slightly inflamed. Subsequently, with instillation of the topical non-steroidal anti-inflammatory agent bromfenac 0.09% (MEGABROM®, Sun Pharmaceuticals, Kamrup, Assam, India), the inflammation and vision improved.

One month later, the BCDVA improved to 20/500 OD and 20/32 OS. Figure 1B showed a color fundus photograph in which the cherry-red spot has disappeared and the optic disc has become pale. Corresponding SD-OCT images Figure 2B showed reduced hyperreflectivity in the inner layers associated with thinning of the retinal layers. MCI showed a reduction in whitening of the blue and green reflectance (BR and GR, respectively) (Figure 4B). At the final follow-up 10 weeks later, the BCDVA had improved to 20/320 OD and 20/25 OS, and in the OD the macula had a mottled appearance and the optic disc was pale (Figure 1C). The corresponding SD-OCT image (Figure 2C) showed thinning of the retinal layers.

At subsequent follow-up (Figure 4B) after the initiation and tapering of oral steroids, BR and GR had reduced whitening, and IR showed stippled hyper- and hyporeflective areas. At the final follow-up (Figure 4C), the BR and GR showed a loss of retinal nerve fiber layer pattern with hyporeflective areas. The green color in the composite image had disappeared, indicating reperfusion; this could have been confirmed on FFA, which was not performed in our patient. BCDVA was poor in the OD due to retinal thinning and optic atrophy. Table 1 summarizes the clinical course and imaging features of the patient.

This report is part of a prospective, observational, cross-sectional study with protocol titled "FAVOUR": "Fever Associated Visual Outcome in Uvea and Retina", which was approved by the Hospital Ethics Committee (EC Ref No: C/2018/08/05). All tenets of the Declaration of Helsinki were adhered to, and written informed consent was obtained from the patient to participate and publish the findings.

DISCUSSION

We have reported the case of a 53-year-old woman with blurred vision and CRAO in the OD two months after a bout of viral fever. She underwent a systemic evaluation to diagnose the cause of retinal artery occlusion, with the only significant finding being an increased dengue IgG titer. She was administered oral steroids and underwent serial multimodal imaging with documentation of changes and partial recovery of vision.

Retinal vascular occlusion can occur due to systemic conditions, such as diabetes, hypertension, hyperlipidemia, autoimmune diseases, atherosclerosis, and cardiac conditions [15-18]. Hematological conditions predisposing to increased levels or activity of procoagulant factors (prothrombin, factor Va, thrombin, fibrinogen), decreased levels or activity of endogenous anticoagulants (protein C, protein S, antithrombin III), decreased levels or activity of fibrinolytic compounds (plasminogen and plasmin), increased levels or activity of lipoproteins, or genetic mutations in factor V may cause retinal vascular occlusions [15-18].

In this case, we used MCI to demonstrate the changes in BR and GR before and after oral steroid administration. A summary of recent publications, during the years 2018–2022, highlighting different eye diseases and the role of MCI in their diagnosis and serial monitoring is presented in Table 2. In this table, we summarized the observations of MCI and its advantages found in published papers. The list is not exhaustive; however, it highlights the salient features of different retinal and choroidal disorders [19-38].

Our patient had a febrile illness and two months later developed blurred vision. Inflammatory branch retinal artery and vein occlusion with panuveitis secondary to dengue fever has been reported [4]. CRAO secondary to dengue fever has also been previously described [39]. Their 50-year-old patient developed complete ophthalmoplegia with CRAO seven days following dengue fever. Unfortunately, no color fundus photographs or FFA results were available in that article. There was also no mention of IgG antibodies or thrombocytopenia during the ocular presentation. Our patient had decreased BCDVA with mild retinal edema and thickening. Delayed, but not completely interrupted blood flow on FFA indicated resolution of CRAO.

Branch retinal artery occlusion secondary to dengue fever has been reported, wherein the patient received no treatment and visual acuity remained stable, although persistent inferior altitudinal defects were present [40].

In dengue fever, viral invasion may be a more likely cause of hepatitis, whereas vascular hyperpermeability (contributing to most ocular manifestations) may be predominantly mediated by the immune response [41]. Usually, in the convalescent phase of dengue fever, ophthalmic manifestations implicate the host immune response rather than direct viral infection [42]. The need for oral steroid treatment in our patient may be debatable, as the illness might have spontaneously resolved. The immune component of dengue fever-related vascular insults usually responds to steroid therapy, especially in those with poor vision [1, 3].

The strengths of this case report are the non-invasive serial monitoring of CRAO using SD-OCT and MCI technology and our summary of the literature concerning clinical applications and advantages of MCI. A limitation was that a full thrombophilia evaluation was not possible due to financial constraints. Repeat FFA was also not performed for this reason, and this would have helped determine the actual state of the retinal vascular network after recovery. The OCTA images did not reveal any useful information due to projection artifacts at presentation, thus images were not included in this report as they had artifacts due to fixation loss and poor centration. In the future, serial follow-up of patients with retinal vascular occlusions can be performed in larger studies using a combination of color fundus photography, MCI, SD-OCT, and OCTA, obviating the need for invasive FFA, which may be restricted to a selective few cases for assessment of the retinal periphery.

CONCLUSIONS

CRAO can occur a few months after recovery from viral fever, just as positive IgG serology indicated subacute dengue fever in our patient. Our patient was managed with a tapering dose of oral steroids. Apart from the systemic causes of retinal vascular occlusion, this case report demonstrates post-infection as a possible cause. MCI is a noninvasive method for serial monitoring or documenting improvement. This case report demonstrated the disappearance of green areas on pseudocolor images, indicating reperfusion.

ETHICAL DECLARATIONS

Ethical approval: This report is part of a prospective, observational, cross-sectional study with protocol titled "FAVOUR": "Fever Associated Visual Outcome in Uvea and Retina", which was approved by the Hospital Ethics Committee (EC Ref No: C/2018/08/05). All tenets of the Declaration of Helsinki were adhered to, and written informed consent was obtained from the patient to participate and publish the findings.
Conflict of interests: None

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