Multimodality Diagnostic Imaging in Unilateral Acute Idiopathic Maculopathy

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Objective: To describe the clinical features and imaging characteristics in unilateral acute idiopathic maculopathy.

Methods: Retrospective review of 4 patients with a diagnosis of unilateral acute idiopathic maculopathy. Clinical characteristics (age, symptoms, Snellen visual acuity, and funduscopic features) and images from spectral-domain optical coherence tomography, fundus autofluorescence, fluorescein angiography, and indocyanine green angiography were analyzed.

Results: The median (range) age at presentation was 31 (27-52) years. The median (range) interval between symptom onset and presentation was 4 (1-20) weeks. Associated systemic findings included a viral prodrome (50%), orchitis (50%), hand-foot-mouth disease (25%), and positive coxsackievirus titers (50%). The median (range) vision acuity at initial examination was 20/400 (20/70 to 1/400), which improved to 20/30 (20/20 to 20/60) at final follow-up. The median (range) follow-up time was 8 (8-13) weeks. Early in the disease course, the central macula developed irregular, circular areas of white-gray discoloration. Following recovery, the macula had a stippled retinal pigment epithelium characterized by rarification and hyperplasia. Fluorescein angiography demonstrated irregular early hyperfluorescence and late subretinal hyperfluorescence. Spectral-domain optical coherence tomography showed a partially reversible disruption of the outer photoreceptor layer. Fundus autofluorescence initially revealed stippled autofluorescence that eventually became more hypoautofluorescent. Indocyanine green angiography showed “moth-eaten”-appearing choroidal vasculature, suggestive of choroidal inflammation.

Conclusions: The imaging characteristics highlight the structural changes during the active and resolution phases of unilateral acute idiopathic maculopathy. The visual recovery correlates with structural changes and suggests that the pathogenesis involves inflammation of the inner choroid, retinal pigment epithelium, and outer photoreceptor complex that is partially reversible.

lipofuscin, and has been used for the evaluation of age-related macular degeneration, inflammatory maculopathies, and retinal dystrophies. The axial resolution of most spectral-domain OCT technology is approximately 5 µm, which allows for detailed assessment of the integrity of specific retinal layers and provides insight into pathogenic processes during disease progression and recovery. The purpose of this study was to further characterize the features of UAIM using multimodality imaging techniques and to correlate the ultrastructural choroidal, RPE, and retinal changes during the acute and convalescent phases of the disease with the recovery of visual function.

METHODS

The institutional review board of Emory University approved this study. All work pertaining to this project maintained compliance with the Health Insurance Portability and Accountability Act. We reviewed the medical records of consecutive patients who were given a diagnosis of UAIM from January 1, 2009, through December 31, 2010. Four patients with clinical features of UAIM were included for analysis. The demographic information, age at presentation, month of presentation, visual and systemic symptoms, ocular and medical history, family history, and detailed medication history were recorded for each patient. Snellen visual acuity, funduscopic features, electrotinography findings, and the results of clinical diagnostic imaging (spectral-domain OCT, FAF, fluorescein angiography, and ICG angiography) were also reviewed.

Retinal photography of the macula and fluorescein angiography were performed using a Topcon TRC 50DX retinal camera (Topcon America Corporation). Time-domain OCT was performed using the Stratus OCT (Carl Zeiss Meditec, Inc), and spectral-domain OCT images were taken on the Cirrus-HD OCT4000 instrument (Carl Zeiss Meditec, Inc). High-speed ICG angiography and FA images were recorded using a modified confocal scanning laser ophthalmoscope (model HRA2; Heidelberg Engineering). Full-field electrotinography was used in 1 patient, and results were recorded in accordance with the International Society for Clinical Electrophysiology and Vision protocol on a Nicolet Bravo system.

RESULTS

The clinical characteristics of the 4 study patients are included in the Table. All patients were healthy except patient 4, who had controlled hypertension. The median (range) age at presentation was 31 (27-52) years. All patients were seen with a complaint of acute-onset, unilateral, painless vision loss. Three patients (75%), all of whom sought care shortly after symptom onset, were seen during the late summer months (June through September). Patient 4 had amblyopia in the involved eye and sought care 5 months after his initial visual disturbance.

Two patients (patients 1 and 2) described a viral prodrome and 1 patient (patient 1) described the clinical signs and symptoms of hand-foot-mouth disease (HFMD). Two patients (patients 2 and 3) concomitantly developed orchitis or epididymitis around the time of vision loss. In addition, 2 patients (patients 1 and 3) had positive titers for coxsackievirus around the time of presentation.

The median (range) visual acuity at presentation to our institution was 20/400 (20/70 to 1/400), which improved to 20/30 (20/20 to 20/60) at final follow-up. The median (range) follow-up time was 8 (8-13) weeks.

FUNDUSCOPIC FEATURES

Most patients initially manifested irregular, circular areas of mild white-gray discoloration of the central macula. Patient 1 initially had a subfoveal exudative neurosensory retinal detachment (Figure 1) that resolved 1 week after symptom onset. During the initial 2 to 3 weeks, the macula developed well-circumscribed areas of RPE atrophy and hyperplasia. Despite the abnormal fundusoscopic appearance during the disease process, the visual acuity improved dramatically. Figure 2 shows the fundusoscopic appearance and imaging characteristics 1 week after symptom onset for patient 1. Most patients showed increased retinal pigment hyperplasia as time progressed (Figure 3).

OPTICAL COHERENCE TOMOGRAPHY

Time-domain OCT was performed in patients 1, 3, and 4. One patient had subfoveal subretinal fluid documented with time-domain OCT shortly after symptom onset. Retinal thinning and irregularity of the outer photoreceptor layer was the most prominent finding in the time-domain OCT images from later in the disease course. Spectral-domain OCT was performed in patients 1 and 2. Both had disruption and irregularity of the outer photoreceptor layer early after disease onset. The external limiting membrane was well preserved in each case. Later in the course of this condition, the outer photoreceptor layer appeared to be normalizing (Figure 3).

FAF IMAGING

Patients 1, 2, and 4 underwent FAF imaging. The alteration in autofluorescence corresponded to the clinically significant lesion on fundusoscopic examination. Earlier in the course of the disease, the demarcation line between hypoautofluorescence and hyperautofluorescence was distinct. The lesions showed a complex, mixed pattern of hypoautofluorescence and hyperautofluorescence, typically involving the fovea or peripapillary region. Later in the disease course, the affected areas displayed decreased hyperautofluorescence and became more hypoautofluorescent (Figure 3), suggesting loss of the RPE. The shift from hyperautofluorescence to hypoautofluorescence paralleled the visual acuity improvement.

FLUORESCIN AND ICG ANGIOGRAPHY

All 4 patients underwent fluorescein angiography, and patient 1 had an ICG angiogram. Patient 1, who sought care very early in the disease course, showed subretinal
fluid leakage with pooling in the central macula that resolved 1 week later. In the subacute and chronic phases of the disease, the macula from each patient showed a well-demarcated, speckled pattern of subretinal fluorescein staining (Figure 4 and Figure 5). Patient 1 underwent ICG angiography approximately 2 weeks after symptom onset with an irregular “moth-eaten” appearance of the choroidal vasculature throughout the involved area (Figure 2). There were no areas of abnormal hyperfluorescence or definite leakage.

**ELECTRORETINOGRAPHY**

The full-field electroretinogram was performed on patient 1 approximately 2 weeks after symptom onset. The result showed mildly diminished 30-Hz flicker amplitudes, suggesting mild cone dysfunction, and was otherwise unremarkable.

In this series of patients with UAIM, multimodality diagnostic imaging was helpful in identifying the structural changes that occur and evolve during the early phases of this disease process. These findings provide insight related to the pathogenesis of this rare maculopathy. The FAF signal, which is primarily derived from lipofuscin deposition within the RPE,8 was particularly revealing. Specifically, the abnormal stippled hyperautofluorescent pattern observed in the acute phase of UAIM evolved into a more stellate pattern in the late phase of the disease, while concomitant loss of the surrounding background autofluorescence suggested a fibrotic process with loss of normal RPE cells in the foveal and perifoveal region. In some cases, the changes follow along the distribution of the papillomacular bundle. High-speed ICG an-

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**Table. Clinical Characteristics of Study Patients With UAIM**

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Onset Systemic Findings</th>
<th>OCT</th>
<th>FAF</th>
<th>VA</th>
<th>Follow-up, wks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F/27 Sept</td>
<td>HFMD; positive coxsackievirus A9</td>
<td>Day 1: irregular subretinal leakage/central pooling with neurosensory detachment; week 1: irregular stippled subretinal staining/leakage</td>
<td>Small subfoveal neurosensory detachment; week 1: PRL disruption presentation with preservation of external limiting membrane</td>
<td>Partial restoration of PRL and HRAF</td>
<td>Largely HOAF with granular HRAF</td>
</tr>
<tr>
<td>2/M/30 Aug</td>
<td>Viral prodrome; orchitis</td>
<td>Week 7: outer circular ring of subretinal staining, middle ring of blockage, and central ring of subretinal staining</td>
<td>PRL disruption with preservation of external limiting membrane</td>
<td>Partial restoration of PRL</td>
<td>Mixed HOAF and HRAF</td>
</tr>
<tr>
<td>3/M/31 July</td>
<td>Orchitis; positive coxsackievirus B2/B5</td>
<td>Week 1: outer circular ring of subretinal staining, middle ring of blockage, and central ring of subretinal staining</td>
<td>Mildly noncystic edema of neurosensory retina</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>4/M/52 Oct</td>
<td>None</td>
<td>Month 5: granular area of subretinal staining and blockage</td>
<td>Atrophic retina</td>
<td>Well demarcated HRAF with specks of HOAF</td>
<td>...</td>
</tr>
</tbody>
</table>

Abbreviations: FA, fluorescein angiography; FAF, fundus autofluorescence; HFMD, hand-foot-mouth disease; HOAF, hypoauflorescence; HRAF, hyperauflourescence; ICG, indocyanine green angiography; OCT, optical coherence tomography; PRL, photoreceptor layer; UAIM, unilateral acute idiopathic maculopathy; VA, visual acuity.

*Dates indicate time after onset of symptoms.*
Dilated choroidal vessels and neighboring "moth-eaten" vessels were suggestive of active choroidal inflammation and disturbance of the RPE layer. The absence of retinal vascular and optic disc hyperfluorescence suggests that disease activity was localized at the inner choroid, RPE, and outer retina. However, we do note that papillitis has been previously reported.

Early in the disease process, OCT imaging confirmed the presence of a subfoveal neurosensory detachment, possibly resulting from underlying choroidal vasculitis or choroidal congestion and resultant RPE injury. Spectral-domain OCT demonstrated that outer segment photoreceptor disruption and injury occurs during the acute phase of UAIM. Interestingly, the anatomic disruption in this layer appears to be at least partially reversible. The photoreceptor layer was partially restored in patients 1 and 2; however, anatomic improvement lagged behind the visual recovery. Furthermore, each case seems to have a hyperreflective material during the acute phase of UAIM, which may represent photoreceptor outer segments. Multimodal imaging later in the disease course demonstrates at least partial resolution of this material.

The integrity of the outer photoreceptor layer, specifically the inner segment/outer segment (IS/OS) junction, has been a topic of increasing interest with the evolution of more sophisticated imaging modalities. Inoue and colleagues showed that the persistent disruption of the IS/OS junction correlated with poor visual outcome in patients who had epiretinal membrane surgery. The authors speculated that postoperative inflammation may lead to reversible damage to the photoreceptors in some patients. Several other studies also suggest a similar correlation between IS/OS junction disruption and visual potential. In patients with diabetic macular edema, Maheshwary et al reported that the integrity of the IS/OS junction is an important predictor of visual acuity. In the current study, the IS/OS junction was significantly disrupted during the acute phase of the illness, yet there was partial restoration of the photoreceptor integrity 2 to 3 months after symptom onset in some patients. The relatively good visual recovery and OCT findings in these patients with UAIM suggest that the outer photoreceptor layer injury is partially reversible. Preservation of the external limiting membrane may indicate that the inner retina, cell nuclei, and cellular structures necessary for outer segment regeneration remain intact. Furthermore, it is possible that restoration of RPE pump function occurs following resolution of the acute inner choroidal inflammatory process with secondary resolution of the subretinal fluid and photoreceptor debris. The inflammation may be either directly or indirectly related to coxsackievirus infection.

The precise mechanism of coxsackievirus tissue injury in UAIM is still unclear. Multiple reports have documented the association of HFMD with UAIM. Originally described by Robinson et al in 1958, HFMD occurred as an outbreak of vesicular and ulcerative stro-
matitis associated with a maculopapular rash and vesicles on the hands and feet.16 Hand-foot-mouth disease is usually a self-limited, benign condition in children younger than 10 years, but adults may also be affected.16 Hand-foot-mouth disease is most frequently associated with coxsackievirus serotype A16 or enterovirus 71, but multiple serotypes, including A2, A5, A7, A9, A10, B1, B2, B3, B4, and B6, have been reported in association with HFMD.5,17-19 In this study, 1 patient had clinical signs of HFMD, developed vision loss in temporal proximity with the evolution of the rash, and had an elevated coxsackie A9 viral titer. Although HFMD associated with coxsackievirus A16 has a more benign course, outbreaks of enterovirus 71 have been associated with serious clinical findings, including encephalitis, fatal pulmonary edema, and myocarditis.18 In addition to HFMD, the coxsackievirus has been associated with orchitis, epididymitis, and other ophthalmic pathologies.5,17,19-26

Uveitis associated with coxsackievirus has been reported in several cases.19-23 One patient with a serotype B4 infection developed iridocyclitis and an occlusive retinal vasculitis.22 In addition, coxsackievirus B3 and B4 serotypes have been implicated in posterior segment inflammatory conditions with lesions similar to those seen in UAIM.20-23 Coxsackievirus A16 and B6 antibodies were also found to be elevated in a case report of a 30-year-old woman with UAIM.5 Among the positive serotypes found in our patients (A9, B2, B5), none had previously been reported in the English literature to be associated with ocular inflammation.

In this series, a viral prodrome was reported in 2 patients with UAIM. A comprehensive medical history and review of systems was especially helpful in raising our clinical suspicion of UAIM. Specifically, 2 patients reported viral prodromes and 2 had positive coxsackievirus antibodies. One patient was given a diagnosis of HFMD and 2 developed orchitis or epididymitis before the visual loss. Interestingly, 3 of our 4 patients (75%) developed symptoms during the late summer to early fall.
that coxsackievirus transmission is highest during these months, it is feasible that patients with UAIM may seek care more frequently during this season.

The strong association of UAIM with coxsackievirus, viral prodromal illness, and systemic comorbidities, including orchitis and epididymitis, suggests that 2 broad categories of disease mechanism may be involved. First, UAIM may result from direct viral infection. Second, UAIM also may be due to an autoimmune response in the setting of the viral infection. Indeed, coxsackievirus B3 is capable of infecting RPE cells in vitro, and it is possible that hematogenous spread to the RPE may occur during coxsackievirus-associated viremia.27 Another category of disease mechanism relates to immune-mediated damage, as typified by coxsackievirus-associated myocarditis.28 Specifically, molecular mimicry from coxsackievirus proteins may lead to activation of the host immune response and the failure of autoreactive T cells to distinguish between non-self (ie, coxsackievirus) and self-antigen (eg, choroidal, RPE, or outer retina). These processes may subsequently result in local tissue inflammation and structural damage. Although the role of local or systemic immunosuppression has not been explored, most patients with UAIM experience improvement in vision and spontaneous resolution of serous retinal detachments. The use of corticosteroids in this condition could potentially expedite visual recovery by limiting tissue damage. However, because of the potential to worsen a direct viral-mediated process, we do not currently recommend corticosteroid use in this setting.

In summary, we have described the clinical features of UAIM using multimodality clinical imaging, highlighting disease evolution and associated ultrastructural characteristics. Abnormalities on fluorescein angiography, ICG angiography, and FAF suggest the critical role of inflammation at the level of the inner choroid, RPE, and outer retinal layers. Spectral-domain OCT was especially valuable in highlighting the partially reversible disruption of the outer photoreceptor layer. Specifically, the disruption of the IS/OS junction during acute illness was correlated with visual loss, whereas its partial restoration during the convalescent phase of illness corresponded to visual recovery. Although most patients experience a spontaneous improvement in visual acuity, a better understanding of the precise relationship between viral infection and inflammation is needed to target therapies that minimize tissue damage in patients with UAIM.

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REFERENCES


