are required to better understand the risks, benefits, and limits of this therapeutic modality.

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Real-time Ophthalmoscopic Findings of Intraophthalmic Artery Chemotherapy in Retinoblastoma

Superselective intraophthalmic artery chemotherapy (SSIOAC) has become increasingly popular as a treatment for retinoblastoma. We describe the real-time ophthalmic findings of SSIOAC in a 5-month-old baby treated for bilateral disease.

Methods. After obtaining informed consent, SSIOAC was performed under general anesthesia. The right femoral artery was accessed using a Cathlon 24-gauge needle. A 0.018-inch access guidewire was passed through the needle and the needle was removed. A 4F access sheath was installed and attached to a heparin saline flush system. Heparin (100 IU/kg) was administered. A coaxial system was used. The guide catheter was a 4F glidecath (Terumo Europe NV). A straight Marathon microcatheter (0.51 mm; 1.5F at the distal tip; ev3 Neurovascular) was advanced through the guiding catheter right to the ostium of the ophthalmic artery. Selective angiography of the ophthalmic artery was performed. Every 5 minutes, the position of the catheter was checked under fluoroscopy. The infusion consisted of 2.5 mg of melphalan diluted in 30 mL of saline at a rate of 1 mL/min for 30 minutes.

A Retcam 1300 pediatric lens (Clarity Medical Systems) was used to take serial fundus photographs and videos every 4 minutes. The frequency of the imaging was adjusted according to the findings.

Results. Left Eye. During the infusion, there was visible intermittent pallor of the optic nerve and narrowing and blanching of the retinal vessels were noticed 24 minutes into the infusion. C, Immediate reperfusion was noticed when the injection was stopped, allowing for completion of the treatment.

Figure 1. Real-time ophthalmoscopic evaluation of the left eye. A, Pretreatment photograph. B, Visible pallor of the optic nerve and narrowing and blanching of the retinal vessels were noticed 24 minutes into the infusion. C, Immediate reperfusion was noticed when the injection was stopped, allowing for completion of the treatment.
(Figure 1C). No areas of choroidal ischemia or retinal precipitates were noted.

**Right Eye.** Sixteen minutes into the infusion, whitening of the nasal choroidal vasculature was noticed (Figure 2B). These changes were followed by severe generalized vasoconstriction of the retinal arteries and veins that progressed to total obscuration of the retinal arteries with no visible blood flow. The retinal arteries then completely whitened, consistent with intravascular retinal precipitates (Figure 2C). The infusion was stopped 1 minute later. The retinal and choroidal circulation remained compromised for an additional 3.5 minutes. The procedure was aborted after injecting 1.3 mg of melphalan in 15 mL of saline. Findings on fluorescein angiography performed 1 day later were unremarkable.

Signs of tumor regression were noticed in both eyes 1 week later. There were no systemic complications.

**Comment.** Transient acute chorioretinal ischemia can be detected during SSIOAC with melphalan. Isolated diffuse retinal vasculature blanching was immediately reversed, allowing for completion of treatment in the left eye. Vascular changes affecting both the retina and choroid in the right eye required additional time to recover and caused us to abort our treatment. We do not yet know the clinical significance of these ischemic episodes. Vasodilators such as nitroglycerin may prove useful. Also, the addition of real-time ophthalmoscopic observation into the current treatment protocol may alert the physician to tailor treatment to prevent acute toxic effects. We observed a favorable outcome of the tumor in the right eye despite a lower dose of chemotherapy. We can speculate that this effect may be either a direct response to melphalan or an indirect response to transient ischemia.

Our results are similar to those that Wilson et al found in a nonhuman primate model. We too had pulsatile optic nerve and choroidal blanching, retinal artery narrowing, and retinal artery precipitates. Other reported vascular complications from SSIOAC include avascular retinopathy, microemboli to retina and choroid, vitreous hemorrhage, ophthalmic artery stenosis, concomitant central or branch retinal artery occlusion, and choroidal atrophy.

To our knowledge, we are the first to describe transient chorioretinal ischemia during SSIOAC with melphalan in real time. Direct visualization of the fundus dur-
ing the infusion may help to recognize this adverse effect and adjust the treatment accordingly. The early and long-term adverse effects of SSIOAC on the retinal and choroidal vasculature should be investigated.

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**Table. Associations of the Different Types of Age-Related Maculopathy With ARMS2 A69S Genotypes, Adjusted for Age, Sex, CFH Y402H Genotypes, and Smoking**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Early ARM1 (n = 144)</th>
<th>Early ARM2 (n = 110)</th>
<th>Late Atrophic ARM (n = 34)</th>
<th>Late Neovascular ARM (n = 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT</td>
<td>1.52 (1.03-2.23)</td>
<td>1.45 (0.85-2.49)</td>
<td>1.78 (0.70-4.50)</td>
<td>2.47 (0.98-6.23)</td>
</tr>
<tr>
<td>TT</td>
<td>4.60 (1.54-13.73)</td>
<td>13.77 (5.18-36.66)</td>
<td>23.63 (5.28-105.67)</td>
<td>16.15 (3.32-78.59)</td>
</tr>
</tbody>
</table>

Abbreviation: ARM, age-related maculopathy.

*Values are statistically significant at *P* < .05.*

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