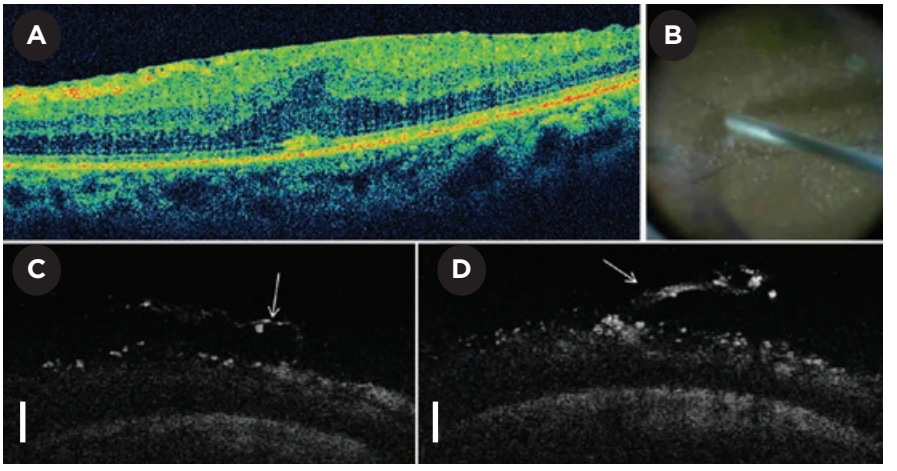



***PATIENT WITH ERM.*** *(A) Desktop OCT shows an ERM and macular edema. (B) Intraoperative microscope image shows OCT probe in place under chandelier illumination. (C, D) OCT images of a half-peeled ERM and the internal limiting membrane. Particles of triamcinolone are seen on the retina and the ERM. Scale bars: 500 µm.*

## Intraoperative OCT With Fiberoptics

**MANUAL DEVICES AND SURGICAL** microscopes that can perform optical coherence tomography (OCT) during vitreoretinal surgery have been available in the United States for a few years. Now, a new fiberoptic probe, made for microinsertion into the eye, can expand the capabilities of intraoperative OCT, Japanese researchers have found.

"Handheld-type and scope-mounted OCT give us images of intraoperative retinal configurations, mainly in the posterior retina. On the other hand, this intraocular fiber-type OCT enables us to obtain images of tissues anywhere in the eye," said Hiroko Terasaki, MD, PhD, professor and chairman of ophthalmology at the Nagoya University, in Nagoya, Japan. Dr. Terasaki and coauthors reported last summer on their early clinical testing of the fiberoptic system.[1]

**Probe fits through microincision.** The fiberoptic, swept-source OCT probe (Nidek) is inserted through the same type of 23-gauge trocar used for microincision vitrectomy. Its scanning laser beam is at a 43-degree angle to the visual axis. By rotating the fiberoptic, the surgeon can visualize not only the posterior retina but also the peripheral retina near the trocar, the ciliary body, and tissues in the anterior chamber.

The images are displayed in real time on a screen mounted next to the ocular of the operating microscope. The device has axial and lateral resolutions of 3.65 µm and 80 µm, respectively, and the scanning laser's central wavelength is 1,060 nm. During pilot clinical testing in 3 patients, the researchers said, this wavelength enabled them to acquire detailed information on deeper retinal and choroidal tissues, including the optic disc.

**Can aid in surgical decision making.** "The image quality may not be sufficient for a precise analysis of retinal thickness. However, it should give surgeons adequate information to make a decision on how to proceed with intraoperative procedures," they wrote.

For example, the group presented the case of a patient with epiretinal membrane (ERM). The fiberoptic OCT probe was able to show the half-peeled ERM, particles of triamcinolone acetonide, and the incision site with the trocar still in place (see Figure).

**Limitations.** However, the researchers noted several current limitations:

• The surgeon must take care to prevent intraocular injury from the probe tip, by holding it 1.5 mm to 2 mm away from the target tissue.

• The surgeon's eyes must move about 30 degrees to the side to view the OCT display screen, which could cause a loss of the microscope view.

• The images lose contrast if illumination in the optical system decreases or if there are motion artifacts from rotation of the fiberoptic inside its cable.

These limitations may be overcome in the near future, said Dr. Terasaki, by development of a new 25-gauge fiberoptic probe, heads-up surgery, and improvement of the OCT system.

**Applications.** According to Dr. Terasaki, "Intraoperative OCT allows the surgeon to detect a tissue abnormality that was obscured by a media opacity before surgery or to see how the surgery itself changed the retinal condition. For instance, intraoperative OCT can reveal that there was a retinal tear during surgery, which may prevent the need for a second procedure later."

*—Linda Roach*

1 Asami T et al. *Invest Ophthalmol Vis Sci* [Special Issue]. 2016;57(9):OCT568-574.

**Relevant financial disclosures**—Dr. Terasaki: Carl Zeiss Meditec: L; Nidek: L, P, S.

NEURO-OPHTHALMOLOGY NEWS

# Risk Factors for NAION Identified

**AT LEAST ONE THING IS KNOWN** about nonarteritic anterior ischemic optic neuropathy (NAION): It is a devastating ocular condition that causes permanent visual loss. Researchers have presumed—but not yet proved—its underlying pathophysiology. And, thus far, few risk factors have been found, other than a small optic nerve head with a small cup-to-disc ratio. Due to the low incidence of NAION, previous small studies about its risk factors have lacked statistical power.[1]

Recently, however, a large retrospective longitudinal cohort study has identified several modifiable risk factors, adding insight into this largely inscrutable condition. Drawing from a pool of nearly 1.4 million eligible enrollees in a large U.S. managed care network, researchers at the University of Michigan and the Massachusetts Eye & Ear Infirmary, Harvard University, assessed more than 20 social, demographic, systemic, and ocular risk factors for NAION among 977 patients who developed the condition between 2001 and 2014.[1]

**Methodology.** Beneficiaries between the ages of 40 and 75 with no previous history of NAION at baseline were monitored for at least 2 years and were seen at least twice by an eye care professional. New diagnoses of NAION arising in this group were identified based on ICD-9 billing codes. The researchers excluded conditions that can mimic NAION, such as giant cell arteritis and optic neuritis, as well as patients who had undergone lumbar spine surgery, which has been linked with ischemic optic neuropathy.

**Systemic and ocular risks.** "We found that systemic hypertension is by far the main modifiable vascular risk factor for this disease, which is consistent with the vascular hypothesis of NAION," said lead author Dean M. Cestari, MD, assistant professor in the department of ophthalmology at Harvard Medical School. In addition, patients with blood-clotting abnormalities had a 146% increased hazard of a NAION diagnosis. Although previous studies have linked diabetes to NAION, this study showed an increased risk of NAION only in diabetic patients with end-organ involvement in comparison to well-controlled diabetics.

Ocular associations with NAION were seen only with age-related macular degeneration (AMD) and retinal vein occlusion (RVO). Patients with RVO were 4 times more likely to develop NAION than patients without RVO. "Given that CRVO can cause a swollen optic nerve head," said Dr. Cestari, "we were initially concerned that this finding of an increased risk could have been due to a coding issue. But after controlling for this, it turned out not to be the case."

**Demographic factors.** As expected, age was a risk factor: Each additional year was associated with a 2% increased risk of NAION. Less expected was a correlation between NAION and gender and ethnicity: NAION was more common in men than in wom-

PEDIATRIC ANATOMY

# Optic Nerve Growth in Kids

The optic nerve in a full-term infant grows rapidly in the first 3 years of life, achieving 86% of its total adult length, and then gradually elongating further until age 15, an unprecedented in vivo study has found.[1]

**A surprising information gap.** Researchers at the University of Maryland uncovered these findings while pursuing their primary objective—trying to identify molecules active during development that eventually might be used to repair damage in the mature optic nerve, said coauthor Steven L. Bernstein, MD, PhD.

"But when we were trying to understand the mechanisms of optic nerve growth, we were unable to find any original studies describing the pattern of optic nerve lengthening either in living individuals or in normal postmortem specimens. No prior studies had evaluated the growth of the normal living infant optic nerve," said Dr. Bernstein, professor and vice chair of research in the university's Department of Ophthalmology and Visual Sciences, Anatomy and Neurobiology.

**MRI to the rescue.** To begin filling this information gap, the researchers analyzed magnetic resonance imaging (MRI) scans from 12 normal full-term newborns enrolled in the federally funded Infant Brain Imaging Study (IBIS).[2] This showed that the newborns' optic nerves had a mean length of 25.3 ± 0.3 mm.

Subsequent IBIS scans of those infants at 1 year of age, plus brain images from other individuals scanned for unrelated reasons at ages 3, 5, 10, 15, and 20 years of age, showed the optic nerve lengthening rapidly until about age 3. The axons then elongated much more slowly through age 10, followed by a final, accelerated growth spurt that abated at age 15, the researchers reported.

"The study itself will help pediatric ophthalmologists understand when the [optic] nerve is most sensitive to damage from radiation or chemotherapy," Dr. Bernstein said. "But it is also very useful in basic labs—which is what we're using it for—to evaluate when the nerve would be most likely to have advanced regenerative capacity, in order for us to examine those processes." *—Linda Roach*

1 Bernstein SL et al. *Eye (Lond)*. 2016;30(10):1378-1380.
2 NIH Autism Center of Excellence. Infant Brain Imaging Study. www.ibisnetwork.org/. Accessed Oct. 25, 2016.

**Relevant financial disclosures—**Dr. Bernstein: His university has applied for a patent related to this work.

en; however, both Latinos and Latinas were highly protected from the disease. This points to potential hormonal and genetic influences, said Dr. Cestari. "Preliminary data from more than 60 samples have revealed more genetic abnormalities than you would expect in this disease." The researchers are following up with a genetic study of NAION patients around the country.

**Clinical practice and collaboration.** Although it's premature to suggest treatment based on this study's findings, said Dr. Cestari, understanding modifiable risk factors such as systemic hypertension may be especially helpful because there is approximately a 30% chance of developing NAION in the second eye within 5 years.

Dr. Cestari applauds the study's collaboration between researchers in glaucoma and neuro-ophthalmology, who used big data to better understand disease risk factors. "These 2 fields have traditionally been considered separate, but as we learn more about diseases that affect the optic nerve, we see they actually have more in common than originally thought. Great research can come from this kind of collaboration."

*—Annie Stuart*

1 Cestari DM et al. *Ophthalmology*. 2016;123 (12):2446-2455.

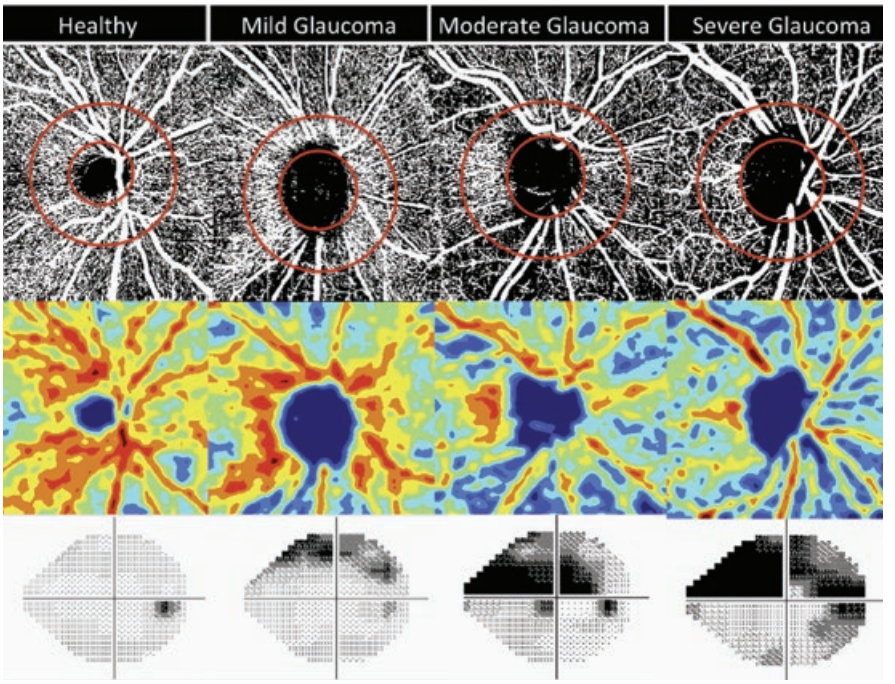
**Relevant financial disclosures**–Dr. Cestari: None.

ANGIOGRAPHY IN GLAUCOMA

# Vessel Density & Visual Fields

**USING ADVANCED IMAGING TECH-**nology, researchers at the University of California, San Diego, have found a significant relationship between vessel density and severity of visual field (VF) damage in glaucoma.[1] The microvascular network got progressively sparser as disease advanced, suggesting that reduced vessel density is associated with more severe disease.

The observational cross-sectional study involved 153 eyes from healthy participants, glaucoma suspects, and glaucoma patients. All eyes underwent imaging using optical coherence tomography angiography (OCT-A) and spectral domain OCT (SD-OCT); VFs were checked with standard automated perimetry. It was OCT-A that yielded information with the potential to transform clinical practice and provide a deeper understanding of the pathophysiology of glaucoma.




***VESSELS AND VF IN HEALTHY AND AFFECTED EYES.*** *(Top row) OCT-A vessel density extracted maps; circles show measurement region. (Middle) Color-coded maps of vessel density. (Bottom) Corresponding visual fields.*

**OCT-A reveals RNFL capillary networks.** OCT-A provides a window into the microvasculature in the optic nerve head, peripapillary retina, and macula, revealing ocular circulation "at a level of precision not achieved with previous instruments," the researchers noted.

They evaluated vessel density, which they defined as the percentage of area occupied by flowing blood vessels in 2 designated regions of the retinal nerve fiber layer (RNFL). After comparing OCT-A observations to standard SD-OCT structural measures, the researchers found that healthy eyes appeared to have denser capillary networks within the RNFL than eyes with glaucoma. Vessel density was lowest in eyes with the most severe disease.

**Linkage with VF damage.** Even after controlling for the severity of structural damage, as measured by rim area and RNFL thickness, the association between vessel density and severity of visual field damage was significant. That strong correlation was an unexpected finding, said Robert N. Weinreb, MD, chairman and distinguished professor of ophthalmology, UC San Diego, who is one of the study's authors.

Dr. Weinreb noted that these findings must be confirmed by others, and information regarding changes over time is needed "before employing this promising new technology for clinical decision making in glaucoma." Eventually, he said, "It may be that these measurements will enhance our understanding of the pathophysiology of the disease and, specifically, the role of microvascular changes."

*—Miriam Karmel*

1 Yarmohammadi A et al. *Ophthalmology.* 2016;123(12):2498-2508.

**Relevant financial disclosures**—Dr. Weinreb: Imaging instruments for research were provided by Heidelberg, Optos, Optovue, Topcon, and Zeiss.

Yarmohammadi A et al. *Ophthalmology.* 2016;123(12):2498-2508.

**See the financial disclosure key,** page 8. **For full disclosures,** including category descriptions, view this News in Review at aao.org/eyenet.