Use of Optical Coherence Tomography to Quantify Macular Edema

Elizabeth Kester, OD and Dianne Kowing, MS, OD

This imaging technique is quickly becoming the new standard, as it is extremely useful in acquiring detailed assessment of macular edema and other retinal abnormalities.

A 66-year-old man presented to the Daytona Beach VA eye clinic with a three-day duration of painless, decreased vision in his right eye. His medical history was positive for atrial fibrillation, hypertension, hyperlipidemia, glucose intolerance, and coronary artery disease. His medications included gemfibrozil, simvastatin, valsartan, and warfarin. His blood pressure, measured on his right arm while he was sitting in the clinic office, was 164/98 mm Hg.

His best corrected visual acuity was 20/50 in his right eye and 20/20 in his left eye. His pupils were equal, round, and reactive to light without an afferent pupillary defect (Marcus-Gunn pupillary defect). Extraocular motilities were complete: The patient was able to move both eyes smoothly in all fields of gaze. He had full confrontation visual fields in both eyes as well. Intraocular pressures in his right eye and left eye were normal at 11 and 13 mm Hg, respectively. An anterior segment examination (including lids, conjunctiva, sclera, cornea, iris, and anterior chamber) was unremarkable in both eyes.

A dilated fundus examination revealed a superior hemicentral retinal vein occlusion in the patient's right eye (Figure 1). Extensive retinal hemorrhages and cotton wool spots were scattered throughout the superior half of the retina. The hemorrhages extended into the macular area and edema was present. A small pre-retinal hemorrhage was present in his inferior retina. Examination of the patient's left eye was unremarkable.

Optical coherence tomography (OCT) was used to measure the central macular thickness in both of his eyes. The central macular thickness in his right eye was 415 µm (Figure 2), indicating extensive edema. The thickness in his left eye was measured centrally at a value of 213 µm—within the normal range of 150 to 250 µm (Figure 3).[1,2]

Given these findings, an initial observation strategy was deemed appropriate for this patient. As such, he continues to be monitored on a monthly basis with OCT, dilated fundus examinations, intraocular pressure measurements, and gonioscopy (anterior chamber angle evaluation) for the development of neovascularization and changes in macular edema or thickness. If observation does not reveal resolution of the patient's macular edema and secondary decreased visual acuity within several months, treatment options include laser photocoagulation and anti-vascular endothelial growth factor (VEGF) intravitreal injections. Anti–VEGF intravitreal-injected medication is a new, effective treatment for macular edema that became available within the past year. Many retinal specialists are administering this therapy at the time of retinal vein occlusion diagnosis, but others continue to observe initially.

Overall management of the patient's condition included collaboration with his primary care provider for improved hypertension control and referral to the cardiology department for management of his preexisting cardiovascular disease.

ABOUT THE CONDITION

Occlusion of the retinal venous system is a common retinal vascular disease whose cumulative 10-year

Dr. Kester is a staff optometrist and **Dr. Kowing** is the chief of optometry at the William Chappell VA Outpatient Clinic in Daytona Beach, FL. In addition, Drs. Kester and Kowing are assistant clinical professors of optometry, both at Nova Southeastern University College of Optometry, Fort Lauderdale, FL and Illinois College of Optometry, Chicago.

incidence has been assessed at 1.6% in populations 49 years and older.[3] The most common etiologies of vein occlusions are atherosclerosis and hypertension. Advanced age (70 years or older) is also a significant risk factor for the condition.[3] In addition, glaucoma and optic disc cupping were significant predictors of risk of incident retinal vein occlusion in the Beaver Dam Eye Study.[4]

Complications of retinal venous occlusion include macular edema, intraretinal hemorrhage, capillary nonperfusion, and neovascularization of the anterior and posterior segment.[5] Vision loss commonly results from macular edema, and evaluation and quantification of the edema becomes crucial in assessing resolution and response to treatments.

Macular edema is found in a variety of other ocular conditions as well. These include diabetic retinopathy, pseudophakia (after cataract surgery), uveitis (inflammation of one or all portions of the uvea—choroid, ciliary body, or iris), and retinitis pigmentosa.[1,6]

ADVANCES IN DIAGNOSTIC IMAGING

OCT is a noninvasive, intraocular imaging technique used to assess and monitor macular edema, as well as other abnormalities of the retina, vitreoretinal interface, and optic nerve head.[6] Since its introduction into clinical practice in 1997, it has given practitioners unprecedented levels of information regarding retinal and optic nerve morphology and pathology.[7]

Using light beams to obtain a tomographic cross-section of the retina, OCT provides in vivo optical biopsy of the retina and surrounding structures. The resulting images are high resolution—approximately 10 µm in a cross-section—and are produced in real time.[8] They are derived from analysis

Figure 1. Dilated fundus examination image of the patient's right eye, revealing superior hemicentral retinal vein occlusion with macular edema.

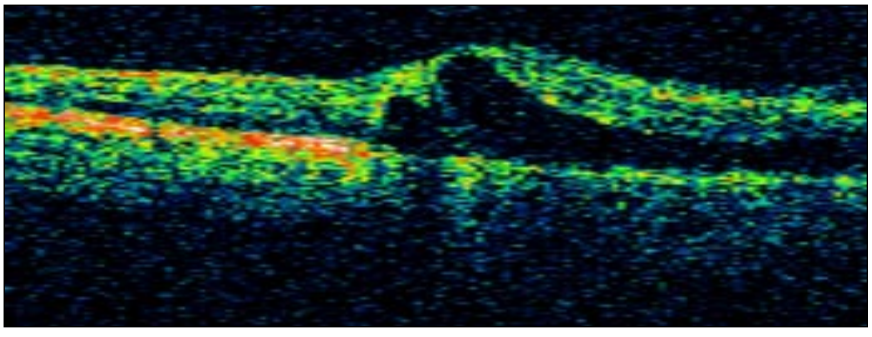

Figure 2. Ocular coherence tomography scan of the patient's right macula, showing diffuse edema with a central macular thickness of 415 µm.

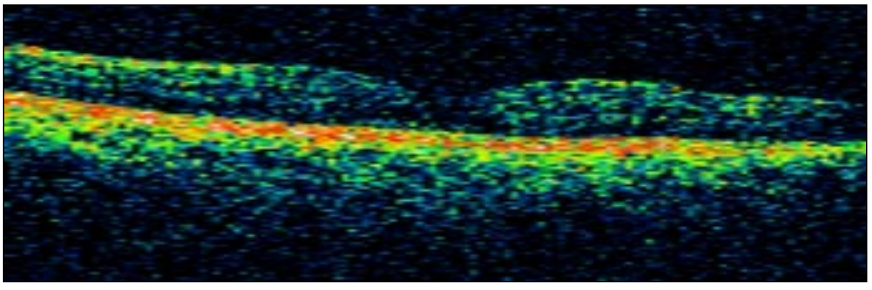

Figure 3. Ocular coherence tomography scan of the patient's left eye, showing a normal left macula with a foveal pit or central depression.

of reflection of low coherence radiation from the tissue being examined.[2]

The precise, high detail, cross-sectional images of the retina allow enhanced viewing and evaluation in diagnosis. OCT also is extremely useful for clinicians to monitor patients' responses to treatments for such retinal conditions as age-related macular degeneration,[9] diabetic retinopathy, macular holes, retinal detachments, and even posterior segment trauma.[10]

In certain clinical situations, OCT can replace or enhance standard fundus fluorescein angiography,[11] which is an invasive technique and uses contrast dye. In fact, with its high level of reproducibility and reliability,[12] as well as its high sensitivity and specificity,[13] OCT is quickly becoming a new standard in retinal imaging technology. ●

The opinions expressed herein are those of the authors and do not necessarily reflect those of Federal Practitioner, *Quadrant HealthCom Inc., the U.S. government, or any of its agencies. This article may discuss unlabeled or investigational use of certain drugs. Please review complete prescribing information for specific drugs or drug combinations—including indications, contraindications, warnings, and adverse effects—before administering pharmacologic therapy to patients.*

REFERENCES

1. Chan A, Duker JS, Ko TH, Fujimoto JG, Schuman JS. Normal macular thickness measurements in healthy eyes using Stratus optical coherence tomography. *Arch Ophthalmol.* 2006;124:193–198.
2. Brancato R, Lumbroso B. *Guide to Optical Coherence Tomography Interpretation.* Rome, Italy: Innovation-News-Communication; 2004.
3. Cugati S, Wang JJ, Rochtchina E, Mitchell P. Ten-year incidence of retinal vein occlusion in an older population: The Blue Mountains Eye Study. *Arch Opthalmol.* 2006;124:726–732.
4. Klein BE, Meuer SM, Knudtson MD, Klein R. The relationship of optic disk cupping to retinal vein occlusion: The Beaver Dam Eye Study. *Am J Ophthalmol.* 2006;141:859–862.
5. Spaide RF, Lee JK, Klancnik JK Jr, Gross NE. Optical coherence tomography of branch retinal vein occlusion. *Retina.* 2003;23:343–347.
6. Catier A, Tadayoni R, Paques M, et al. Characterization of macular edema from various etiologies by optical coherence tomography. *Am J Ophthalmol.* 2005;140:200–206.
7. Wollstein G, Schuman JS, Price LL, et al. Optical coherence tomography longitudinal evaluation of retinal nerve fiber layer thickness in glaucoma. *Arch Ophthalmol.* 2005;123:464–470.
8. Rumelt S, Karatas M, Ophir A. Potential applications of optical coherence tomography in posterior segment trauma. *Ophthalmic Surg Lasers Imaging.* 2005;36:315–322.
9. Van de Moere A, Sandhu SS, Talks SJ. Correlation of optical coherence tomography and fundus fluorescein angiography following photodynamic therapy for choroidal neovascular membranes. *Br J Ophthalmol.* 2006;90;304–406.
10. Rumelt S, Karatas M, Ophir A. Potential applications of optical coherence tomography in posterior segment trauma. *Ophthalmic Surg Lasers Imaging.* 2005;36:315–322.
11. Voo I, Mavrofrides EC, Puliafito CA. Clincial applications of optical coherence tomography for the diagnosis and management of macular diseases. *Ophthalmol Clin North Am.* 2004;17:21–31.
12. Pierre-Kahn V, Tadayoni R, Haouchine B, Massin P, Gaudric A. Comparison of optical coherence tomography models OCT1 and Stratus OCT for macular retinal thickness measurement. *Br J Ophthalmol.* 2005;89;1581–1585.
13. Goebel W, Franke R. Retinal thickness in diabetic retinopathy: Comparison of optical coherence tomography, the retinal thickness analyzer, and fundus photography. *Retina.* 2006;26:49–57.