Essential Diagnostic Devices for Retina and Glaucoma Specialists

These technologies can aid in diagnosis and in developing treatment protocols.

BY KARIM N. JAMAL, MD; PRAVIN U. DUGEL, MD; NILS A. LOEWEN, MD, PhD; AND KRISTY G. AHRLICH, MD

Although the chief focus of CRST Europe *is cataract and refractive surgery, the Editors recognize that some readers are not anterior segment specialists but rather are general ophthalmologists, caring for patients with glaucoma and retinal diseases as a portion of their everyday case mix. As part of the bonus feature on diagnostic technologies in this issue, we present the following overviews of essential diagnostic devices for retina and glaucoma specialists, written by experts in each field.*

Retinal Imaging Devices

By Karim N. Jamal, MD; and Pravin U. Dugel, MD

Imaging technologies have been employed in all fields of ophthalmology to aid our diagnostic capabilities. Recent advances in these technologies have had a profound effect on retinal imaging, in both a diagnostic and prognostic manner.

OPTICAL COHERENCE TOMOGRAPHY

One such modality is optical coherence tomography (OCT). This noninvasive, noncontact technology uses a beam splitter to divide a light source into sample and reference arms, which are then compared and analyzed to generate a cross-sectional view of the macula. OCT has become an important ancillary test to diagnose, confirm, or quantify abnormalities at the vitreoretinal interface, on the intraretinal and subretinal levels, and—depending on the device and algorithm—in the inner choroid. This technology has not only enhanced our understanding of disease processes, but it also has the potential to provide prognostic information for a physician's therapeutic plan.

For example, in the case of pseudophakic cystoid macular edema, the patient may be treated differently if subretinal fluid or vitreoretinal traction is seen in addition to macular cystic changes. With higher-resolution OCT devices, the external limiting membrane and inner segment/outer segment junctions can be seen clearly, and their signal strength may provide information regarding how well a patient's vision will recover following epiretinal membrane peeling or macular hole closure.

OCT may also be at the center of a paradigm shift in how diseases such as diabetic macular edema are described. Rather than using the classic Early Treatment Diabetic Retinopathy Study definitions for clinically significant macular edema, some physicians prefer an OCT-based center-involved versus center-spared analysis to determine which treatment or treatments would be most appropriate for each patient.

FUNDUS AUTOFLUORESCENCE

Fundus autofluorescence (FAF) is a newer imaging modality in which a confocal scanning laser ophthalmoscope is used to detect levels of lipofuscin in retinal pigment epithelium (RPE) cells. Increased FAF has been

TAKE-HOME MESSAGE

- OCT, FAF, and FA are imaging technologies that aid retinal physicians in the diagnosis and prognosis of posterior segment eye disease.
- Diagnostic devices that quantitatively evaluate the structure and function of the optic nerve are vital in diagnosing glaucoma.

shown to occur in age-related macular degeneration (AMD), central serous retinopathy, and various inherited retinal dystrophies. In these conditions, the increased signal may be caused by high levels of lipofuscin within the RPE, subretinal space, or outer retina, possibly due to a disruption of RPE phagocytosis of the outer segments. By measuring this fluorophore, FAF can be useful in various retinal diseases with regard to diagnosis, precise documentation of changes and disease progression, and monitoring the effects of new therapies. Its ability to quantify disease progression allows FAF to act as a prognostic tool in patients with early or advanced AMD.

ANGIOGRAPHY

Fluorescein angiography (FA) remains a staple in retinal diagnostic imaging. In this test, sodium fluorescein is injected into the systemic circulation, usually via the hand or arm. After approximately 10 seconds, the dye arrives in the choroidal circulation. The retina is illuminated with a blue light, which excites the dye, and photographs are taken through a barrier filter. This test is invaluable in assessing vascular leakage, pooling, staining, and capillary ischemia in conditions such as diabetic retinopathy, retinal vein occlusion, exudative macular degeneration, and macular edema.

A final essential diagnostic imaging device for the retina specialist is indocyanine green (ICG) angiography. In a manner similar to FA, the ICG dye is injected into the systemic circulation. ICG is excited by light in the infrared spectrum, and, because the longer wavelengths are able to penetrate the retina more deeply, this test allows the clinician to gather information from the choroidal circulation. Therefore, ICG may be helpful in patients with chronic central serous retinopathy or white-dot syndromes. Recently, ICG has become a valuable adjunct for identifying macular degeneration subtypes that exhibit a poor response to vascular endothelial growth factor (VEGF)-inhibiting injections, such as polypoidal choroidal vasculopathy and retinal angiomatous proliferation. Identification of these lesions can help the retina specialist revise his or her treatment approach.

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Technologies for Glaucoma Diagnosis and Progression Analysis

By Nils A. Loewen, MD, PhD; and Kristy G. Ahrlich, MD

Quantitative evaluation of the structure and function of the optic nerve is vital to diagnose glaucoma. The close correlation of these two factors, along with powerful progression analyses, now allows glaucoma specialists to advise patients regarding their rates of progression. The choice of specific diagnostic devices depends on practice sizes and levels of specialization and varies between private and academic settings. The technologies discussed below are helpful tools to evaluate the optic nerve and retinal nerve fiber layer (RNFL).

STRUCTURE: SD-OCT AND DISC PHOTOS

Spectral-domain OCT (SD-OCT) acquires information about the optic nerve head and RNFL in 3-D, as compared with previous time-domain OCT models that acquired 2-D information. When Medeiros et al[1] compared RNFL analysis with optic disc analysis in glaucoma suspects with normal visual fields, they found that RNFL analysis was more likely to detect early glaucomatous change than optic disc analysis. SD-OCT is a valuable tool to aid in the initial diagnosis of glaucoma because RNFL damage can be detected before it becomes visible on examination or by visual field testing.

In our opinion, the Cirrus OCT (Carl Zeiss Meditec, Jena, Germany) stands out for its ease of use and data presentation for RNFL analysis. A one-page view allows users to compare the right and left eyes using RNFL thickness maps, an inter-eye comparison, and thickness measurements by numbers. The thickness map is especially useful to rapidly identify any deviation from the normal butterfly pattern. The ability to diagnose a glaucomatous optic nerve during initial consultation is complemented by robust progression analysis for follow-up.[2] The macula scan and enhanced depth viewing modes expand the usefulness of the Cirrus OCT.

Anterior segment or corneal or refractive surgery specialists may prefer the RTVue OCT (Optovue, Fremont, California) for its ability to image the cornea, anterior segment, and posterior pole. The Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany) has advanced the limited usefulness of surface contour examination with the confocal scanning laser ophthalmoscope (Heidelberg Retina Tomograph; Heidelberg Engineering) by adding SD-OCT. Multispecialty or academic practices may wish to further upgrade to

> Because the patient's actual visual function is what matters the most, it remains crucial to carefully quantify and correlate function to structure.

include FA, indocyanine green, autofluorescence, and red-free imaging.

Some characteristics of the optic nerve head may defy meaningful SD-OCT analysis and are best seen directly. Sequential or simultaneous stereo photographs of the optic nerve head provide a record of the location of retinal vessels, disc hemorrhages, tilt, depth of cupping, and acquired pits. Data acquisition in the form of photos is timeless. The TRC 50-DX (Topcon, Oakland, New Jersey) provides stereo disc photos as well as fundus imaging and would be suitable for a variety of practice types. For a small or solo practice with a limited budget for diagnostic technology, the Topcon 3D OCT-2000 combines OCT and fundus photography. Sadly, equipment for fixed-angle stereophotography has been discontinued.

FUNCTION: AUTOMATED VISUAL FIELD TESTING

Functional deficits may become apparent in automated visual field testing only when 40% to 50% of axonal loss has occurred. Because the patient's actual visual function is what matters the most, it remains crucial to carefully quantify and correlate function to structure. The introduction of progression rate analysis and the visual field index (VFI) in the most recent Humphrey Field Analyzer (HFA II-i; Carl Zeiss Meditec)—which captures function by anatomical location, emphasizing central visual field changes with a higher ganglion cell density over peripheral changes—allows glaucoma specialists to readily determine how rapidly treatment must be adjusted. The steepness of the VFI slope serves as a valuable tool to help the patient visualize past and present.[3] Although Humphrey technology is more costly, it has also been tested and used extensively in study protocols, making it a good choice for academic centers. However, Octopus systems (Haag-Streit AG, Koeniz, Switzerland), which may be more widely available in Europe and Canada, offer a wide range of test programs, including Goldmann visual fields, at a more competitive product price.

INTEGRATED PROGRESSION ANALYSIS SOFTWARE

Each of these technologies forms only one part of the complete clinical picture of glaucoma, and, as with any evidence, their results may conflict with each other. Previously, this required the physician to evaluate the reliability of each result individually and attempt to fit it into the clinical picture. However, newly developed software integrates multiple structural and functional analyses of glaucomatous change. For example, the Forum information management system (Carl Zeiss Meditec) integrates the results of RNFL measurements, visual field testing, and disc photography, and produces a combined report of structural and functional analysis of progression.[4] These combined reports can be generated from any instruments compatible with Digital Imaging and Communications in Medicine (DICOM), a broadly adopted data exchange format that is compatible with almost all electronic health record systems. Discussing findings on a single screen with patients helps to reinforce the diagnosis and recommend management for a disease that is difficult for most patients to notice and comprehend.

CONCLUSION

A wide variety of instruments is available to aid in the diagnosis and progression analysis of glaucoma. The choice of specific devices can be tailored to the needs of individual practices. Integrated progression analysis software helps physicians to utilize to the greatest extent these highly sensitive tools that assess structure and function. For the first time, these powerful technologies allow physicians who treat glaucoma to provide affected individuals with a fairly reliable—albeit limited—glimpse into their own future. ■

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