HI-TECH WORKSHOP IN THE DETECTION OF GLAUCOMA AND RETINAL DISEASE

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I. Multispectral Imaging (MSI)-RHA-Annidis Health Systems, Inc.

A. Principles

1. Uses multiple monochromatic LED-sourced wavelengths (550 nm to 780 nm) to image different retinal layers
2. Shorter wavelengths image more anterior retinal layers; longer wavelengths image deeper retinal layers including the choroid
3. MSI creates a series of monochromatic, en face spectral slices.
4. Is better than color fundus photography, because fundus photography is limited to the visible spectrum, whereas MSI uses wavelengths that are longer than the visible spectrum and thereby demonstrate more pathology in the deeper retinal layers and choroid than standard fundus photography. This is important in the detection of diseases affecting the outer retina, such as hereditary retinal diseases and AMD. The shorter wavelength is better for the detection of vitreo-retinal interface abnormalities than is fundus photography.
5. Afterimage processing highlights oxygenated and deoxygenated hemoglobin, providing an indication of metabolic activity in the retina and assessment of arterial and venous blood flow (morphological angiography)
6. New developments in the technology allow for better visualization of the choroid and choroidal anomalies

B. Clinical Applications

1. Localization of retinal morphological abnormalities
2. Detection and interpretation of disease based upon the reflected layer
3. Enhanced viewing of obscure or overlapping pathological structures
4. Early detection of risk factors for retinal diseases
5. Allows for detection of more pathology in en face imaging

II. Cirrus Spectral Domain-SD-OCT: Carl Zeiss Meditec, Inc.

A. Principles

1. Infrared light (850 nm) from a superbright laser diode is directed into the retina
2. Backscattered light is detected from several retinal layers and is combined with light reflected off a reference mirror; image is and resolved using Low Coherence Interferometry to produce high resolution cross sections (5 um-7 um using SD-OCT)
3. Resulting image looks like a histological slide section of the retina
    a. can differentiate 6-7 retinal layers in TD OCT and 10 layers in SD OCT
4. Pupil dilation not required
5. OCT Stratus=Time Domain (TD) OCT; Cirrus=Spectral Domain (SD) OCT
    a. SD OCT is faster than TD OCT with higher resolution images-an entire A-scan is captured at once, instead of sequentially, and analyzed by Fast Fourier Transform analysis. More pixels are captured in less time than TD-OCT; pt eye movements do not affect the image

C. OCT Displays

1. Optic Disc Topography
    a. Cross-sectional display
    b. Quantification of stereometric parameters of the disc, neuroretinal rim and cup
2. Macular Analysis
    a. Thickness measurements
        i. In a 1mm circular area around the fovea
        ii. Four juxtafoveal sectors 3.00 mm from the fovea
        iii. Four extrafoveal sectors 6.00 mm from the fovea
3. RNFL Analysis (Optic Disc Cube)
    a. RNFL thickness measurement displayed in 12 clock hours 1.73mm from the edge of the ONH
4. Anterior Chamber Assessment for measurement of anomalies of the cornea, iris and angle

D. Clinical Applications of OCT

1. Increases in retinal thickness secondary to vascular disease and venous-occlusive disease (CSME, CME, Macular Edema)
2. Retinal elevations (serous retinal detachments)
3. Choroidal neovascular membranes
4. Macular hole
5. Vitreo-retinal traction
6. Hereditary retinal disease-Photoreceptor Integrity assessment
7. Juxtapapillary nerve fiber layer loss (3.4mm circular scan)
8. Optic nerve head topography measurements
9. Narrow angle assessment (anterior analysis)

III. Ocular Response Analyzer (ORA): Reichert, Inc.

A. Utilizes a dynamic bi-directional applanation process to provide a direct measure of corneal biomechanical properties.
    a. Similar in procedure to the air-puff tonometer
    b. Patient places chin in a chin rest
    c. ORA automatically positions and centers the air-emitting probe in front of the tested eye
    d. A short, light puff of air is administered to the eye

B. The instrument measures corneal biomechanical properties termed corneal hysteresis **(CH)** and **IOPcc**
    a. **CH**
        i. is a measurement of viscous damping in the corneal tissue
        ii. Is an indicator of the overall integrity of the cornea.
        iii. A low CH or asymmetric CH may be associated with glaucoma
    b. IOPcc
        i. Measures an **IOPcc** due to its ability to determine corneal biomechanical properties

ii. Correlates with Goldmann on average
a. Is less affected by corneal properties, such as elasticity, resistance, and thickness.

C. Clinical Applications
a. Identification of corneal pathologies such as keratoconus and Fuchs' dystrophy
b. Clinical investigations have demonstrated that the CH measurement provides an independent indicator of progression in glaucoma.

IV. RAPDx: Konan, Inc.

A. Principles:
a. Measures consensual pupillary responses objectively using infrared imaging
b. Determines amplitude and latency of pupillary responses automatically
c. Consensual and direct responses are recorded simultaneously to monocular stimuli capturing differential amplitudes, latencies and other key features
d. Responses are recorded onto a graph with quantitative data that denotes abnormal scores in amplitude and latency
e. Beneficial in cases of dark pupils and other conditions where subjective assessment of pupillary responses are difficult
f. Images are captured and analyzed in 1-5 minutes.

B. Clinical Applications:
a. Objective asessment of asymmetric neurological disease
b. Objective assessment of asymmetric glaucoma

V. Optos Retinal Exam: Optos, Inc

A. Principles

1. Uses a scanning laser ophthalmoscope to digitally image the fundus
2. Couples a green laser (532 nm) that scans the sensory retinal through the RPE with a red laser (633 nm) that scans deeper structures from the RPE to the deep into the choroid
3. Provides a 200 degree view
4. Does not require pupil dilation; uses Virtual Point™ technology
5. Captures images in 0.25 sec per eye

B. Clinical Applications

1. Useful for detection of central and peripheral abnormalities without pupil dilation
2. Two lasers help differentiate retinal lesions from choroidal lesions
3. Optos Panaoramic 200C: Allows for non-distorted imaging of the optic nerve head

C. Daytona™

1. Smaller and more compact than other Optos systems
2. 60 lbs in weight
3. Provides standard Optomap imaging
4. Provides Fundus Autofluorescent imaging
a. Important for imaging metabolic activity of the photoreceptors and RPE (hyperautofluorescence)

b. Important for delineating areas of photoreceptor and RPE degeneration (hypoautofluorescence)
c. Clinically applicable for the diagnosis of hereditary retinal disease and progression of AMD.

VI. Spectralis SD-OCT: Heidelberg Engineering Inc.

A. Principles

1. Four light sources:
- 488 nm OPS laser-for Blue Autofluorescence Imaging (useful in hereditary retinal disease and monitoring progression of macular degeneration and geographic atrophy, drusen, PEDs)
-760 nm diode laser for Indocyanine green angiography-(ICGA)
-785 nm diode laser for Infrared Imaging-good for central serous and vitreo-macular traction
-879 nm SLD for the OCT imaging

B. Imaging Modalities
   a. SD-OCT,
   b. FA –simultaneous with OCT
   c. ICGA-simultaneous with OCT
   d. Autofluorescence (Blue Peak Laser)
   e. Red Free
   f. Infrared

C. TruTrack Eye tracking system: a reference scan tracks eye movements and the cross-section scan is moved to match the position of the eye. Stored data is free of artifacts. Scans are automatically taken in the same place each time.; B-scan OCT image is in the same location as the reference fundus SLO image;
D. Scans are compared for progression over time with the smallest measurable change=1 um
E. Acquires images 100 X faster than TD (time-domain) OCT; acquires 40,000 A-scans in 1 second
F. High resolution images –axial resolution = 7 um
G. Noise reduction technology produces the high resolution images with less noise or speckle