**Fundus Auto Fluorescence and high resolution OCT technology for novel detection of Vision Threatening Disease.**

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A. Lipofuscin (LF)
    a. Accumulates in post-mitotic neurons
    b. Seen with aging, severe malnutrition, chronic disease of neurons, cardiac myocytes, skeletal muscle cells, liver cells, etc..
    c. Photoreceptors (PR), Retinal Pigment Epithelium (RPE) Degradation, toxins
        i. PR outer segments (OS)
        ii. RPE
            1. toxin removal
            2. byproducts of the visual cycle accumulates as LF granules
    d. Retinal health assessment
        i. Age, Ocular pathology = LF accumulation seen at the level of the RPE
    e. Lipofuscin cellular toxicity in age and ocular disease
        i. LF accumulation effects:
            1. Loss of cellular cytoplasmic space
            2. Loss of cellular function
            3. Photosensitizing irreversible damage
            4. Apoptosis
        ii. Macular degeneration, lipofuscinopathies (Best's, Stargardt's, macular dystrophy), Glaucoma, and other retinal and vascular pathology
    f. Visual Function and LF
        i. LF measured through Autofluorescence (AF) correlates to change in functional vision
            1. AMD
                a. Early AMD
                b. Micro- Perimetry
            2. RP
            3. Macular translocation surgery
            4. Diabetic Retinopathy (DR) in pan retinal photocoagulation (PRP)

B. Fundus Auto Fluorescence (FAF)

a. Lipofuscin Fluorophores are quantifiable
b. In vivo LF imaging
    i. LF excitation range: 300 – 600 nm
        1. Visible light range: 400 – 700 nm
        2. Visible light can be used to excite LF
    ii. LF emission range: 480 – 800 nm
        1. Maximal: 600 – 640 nm
c. FAF signal/ image
    i. Low, weak signal compared to other fluorescent imaging (fluorescein angiography)
    ii. Requires digital image processing
        1. enhancement, electronic noise reduction
    iii. Benefits include
        1. Non-invasive nature, quick acquisition, & specific study of the RPE cell layer in isolation
d. FAF instruments, specifications, review.
    i. No Standardization between manufacturers or within instruments = differing FAF results.
        1. Laser power, detector sensitivity, correction of refractive errors, image processing steps, media opacities (presence of cataracts), camera axial orientation & corneal vertex, etc.
    ii. Fundus Spectrophotometer
        1. Research labs, small field of view
    iii. Confocal Scanning Laser Ophthalmoscope (cSLO)
        1. High contrast, processed image, multiple scans
        2. E.g., Heidelberg
    iv. Fundus Camera
        1. Lower contrast, single image, real time result, larger field of view
        2. E.g., Canon CX-1

C. FAF Imaging: Anterior Segment
    a. Sclera – pterygium and pinguecula
    b. Aging Lens fluorophores
        i. Can interfere with posterior pole AF imaging.

D. FAF Imaging: Posterior pole
    a. Hypofluorescence
        i. Absence of RPE/ LF and/ or when AF emission is blocked.
    b. Hyperfluorescence

i. Presence of LF or other AF material.

ii. Signal intensity is related to concentration of LF or AF material present.

E. Interpretation of the FAF image including gray scale variances

a. Healthy Eye

i. Hypofluorescent Structures: absence of RPE/ LF and when AF emission is blocked

1. E.g., optic nerve head, blood vessels, fovea

ii. Hyperfluorescent Structures: Presence of LF is in all ages is normal, appears as an overall, diffuse low-grade hyperfluorescent signal throughout the posterior pole, gradually diminishes towards fovea

b. Unhealthy Eye

i. Classification of FAF Pattern in Early and Geographic Atrophy Age related Macular Degeneration, Fundus Auto Fluorescence in Age-Related Macular Degeneration (FAM) Study group

F. High resolution Optical Coherence Tomography (HR-OCT): Interpretation

a. High resolution

i. measured in tissue microns

ii. More resolving power, more visibility, more detail of retinal layers

1. Inner segment (IS) and outer segment (OS) junction line of the PR

b. Scanning the retina: differences between a 3 mm scan and a 12 mm scan

c. Scanning the optic nerve head

i. Assisted software programs in the measurements of Cup/Disc and Rim to Disk in determining the Disk Damage Likelihood System (DDLS)

ii. Optic Nerve Analysis

d. Mydriatic and non-mydriatic use of the HR-OCT

i. Advantages of non-mydriatic use

1. Community-based ocular health screenings, triage, and telemedicine protocol.

ii. Limitations of non-mydriatic

1. small pupil aperture, ocular media opacity, fixation/ cooperation, etc.

e. Scanning beyond the posterior pole (requires pupilary dilation)

f. Time Domain vs. Spectral Domain

i. Importance of identifying good normative studies when selecting OCT technology

G. Clinical relevance of Imaging Technology

a. Tracking temporal changes

i. OCT image registration pattern

ii. Color/ FAF fundus image overlay

b. Internal software measuring tools
    i. Linear, 2D surface, and 3D volume OCT scans
c. Integration of advanced posterior pole imaging technology in ocular disease evaluation
    i. Color imaging software-assisted Technology
        1. Red, Green, Blue (RGB) filter.
            a. Blue channel (wavelength 490 nm): nerve fiber layer.
            b. Green channel (530 to 550 nm): retinal structures including arteries, veins, hemorrhages, exudates versus drusen.
            c. Red channel (610 nm): choroidal vasculature, RPE changes, nevi vs. choroidal melanoma, drusen and AMD changes.
        2. Emboss filter
            a. Positive or negative stereo image with dimensional elevation or depression from a single fundus-camera image
    ii. Image registration pattern, software driven fade-in/ fade-out retinal imaging overlay.

H. Case study presentation
    a. Age Related Macular Degeneration (stages: Early, mid and late)
    b. Geographic atrophy (stages: Early, mid and late)
        i. Tracking GA: Non Invasive (Color fundus photography, FAF) vs. Invasive techniques (FA)
            1. Color fundus photography vs. FAF
                a. Area measurements, Growth rates and Estimates of foveal involvement have demonstrated differences between color and FAF imagery.
    c. Lipofuscinopathies
    d. Diabetic Retinopathy (stages: Early, mid and late)
    e. Glaucoma (stages: Early, mid and late)
        i. Including OCT protocols
    f. Tracking patients on Plaquenil
        i. Protocol which includes OCT or FAF or mfERG
    g. Lupus
    h. Alzheimer's (study of Retinal A/V and NFL)
    i. Other known and unknown pathology detected with FAF and OCT, otherwise UNDETECTED with routine color fundus photography.