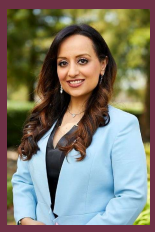
OPTICAL COHERENCE TOMOGRAPHY

The Basics & MORE!

Speaker Disclosures

Roya Attar, OD, MBA, DHA, FAAO, FORS

- Associate Professor & Director of Optometric Services at the University of Mississippi Medical Center Dept of Ophthalmology
- Speaker/Advisory Board Member for
  - Apellis Pharmaceuticals
  - Astellis Pharmaceuticals
  - Heidelberg Engineering
  - B & L
  - Tarsus Pharmaceuticals
  - Glaukos
  - Dompe
  - Tenpoint Therapeutics
  - Optos
  - Sydnexis
- Contact information
  - RoyaAttar@outlook.com
  - Dr.roya_attar
  - Roya Attar



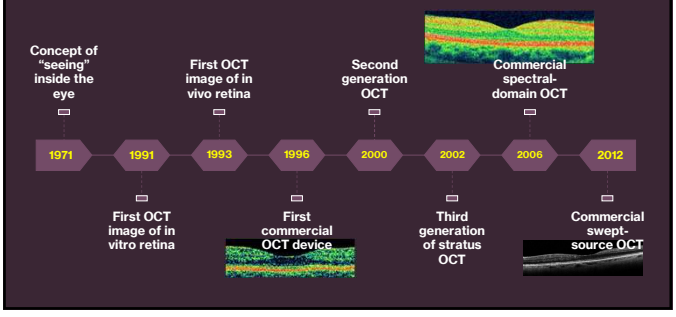
All relevant relationships have been mitigated

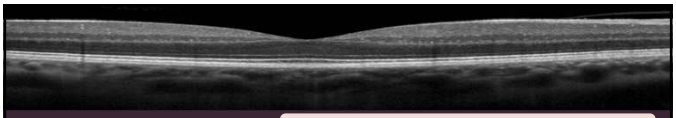
Starting with the Basics

Optical Coherence Tomography (OCT)

- A **non-invasive and non-contact imaging technique** that uses light waves to capture high-resolution images of ocular structures.
- Also used in
  - Cardiology
  - Dermatology
  - Gastroenterology
  - Oncology
  - Otolaryngology
  - Dentistry
  - Neurology

The Evolution of OCT Technology





OCT: The MVP of Imaging

- Earlier Detection & Non-invasive
- Quantitative Analysis & Monitoring
- Diagnostic Confidence
- Treatment Precision

~75% have OCT
~30% want it

Source: Review of Optometry, Annual Technology Report, September 2024

FIG. 5: WHICH OF THESE TOOLS DO YOU ALREADY HAVE?	
Slit lamp	98.8%
Tonometer, Goldmann	92.2%
Autorefractor/keratometer	90.4%
Diagnostic lenses	91.5%
Phoropter, manual	90.7%
EHR with practice management features	79.9%
Tonometer, non-Goldmann	74.2%
Pachymeter	70.1%
Perimeter, conventional	62.8%
Corneal topographer	58.9%
OCT, no angiography	59.4%
Fundus camera, conventional	55.2%
Fundus camera, ultra-widefield	54.1%
Gas permeable/scleral lens fitting sets	50.7%
Phoropter, digital	49.7%
Slit lamp camera attachment	38.9%
Fundus autofluorescence	38.4%
Perimeter, headset	29.8%
B-scan ultrasound	18.4%
Thermal pulsation device for MG expression	17.8%
OCT, with angiography	14.8%
Lid microexfoliation device	14.7%
Wavefront aberrometer	14.1%
Tear osmolarity tester	13.3%
Optical biometer	13.0%
Dark adaptometry	9.8%
ERG	9.8%
Intense pulsed light	9.0%
Scleral topographer	8.3%
Radiofrequency device	8.3%
Low-level light therapy	6.3%

FIG. 6: WHICH ARE YOU CONSIDERING BUYING IN THE NEAR FUTURE?	
Slit lamp camera attachment	27.8%
Perimeter, headset	27.4%
Fundus camera, ultra-widefield	22.3%
Intense pulsed light	22.2%
OCT, with angiography	19.8%
Thermal pulsation device for MG expression	18.4%
Tear osmolarity tester	18.2%
Low-level light therapy	16.2%
Lid microexfoliation device	15.4%
Tonometer, non-Goldmann	13.9%
Corneal topographer	13.7%
Phoropter, digital	12.5%
Optical biometer	12.2%
OCT, no angiography	11.9%
Radiofrequency device	11.8%
Fundus autofluorescence	11.0%
Fundus camera, conventional	9.7%
Pachymeter	9.5%
Scleral topographer	9.0%
Dark adaptometry	7.7%
ERG	7.7%
B-scan ultrasound	7.7%
EHR with practice management features	6.7%
Gas permeable/scleral lens fitting sets	6.1%
Wavefront aberrometer	5.0%
Perimeter, conventional	5.4%
Slit lamp	3.9%
Autorefractor/keratometer	2.0%
Diagnostic lenses	2.0%
Phoropter, manual	1.4%
Tonometer, Goldmann	1.3%

FIG. 7: WHICH WOULD YOU LOVE TO HAVE BUT JUST CAN'T JUSTIFY RIGHT NOW?	
Scleral topographer	82.6%
Dark adaptometry	83.2%
ERG	82.6%
Wavefront aberrometer	80.3%
Radiofrequency device	79.9%
Low-level light therapy	78.9%
Optical biometer	74.8%
B-scan ultrasound	74.5%
Lid microexfoliation device	89.9%
Intense pulsed light	89.4%
Tear osmolarity tester	69.2%
OCT, with angiography	66.9%
Thermal pulsation device for MG expression	66.1%
Perimeter, headset	52.8%
Fundus autofluorescence	50.7%
Gas permeable/scleral lens fitting sets	43.9%
Phoropter, digital	37.8%
Fundus camera, conventional	35.9%
Slit lamp camera attachment	35.4%
Perimeter, conventional	34.5%
OCT, no angiography	29.4%
Corneal topographer	27.4%
Fundus camera, ultra-widefield	23.7%
Pachymeter	20.4%
EHR with practice management features	14.1%
Tonometer, non-Goldmann	11.9%
Phoropter, manual	7.9%
Diagnostic lenses	6.8%
Tonometer, Goldmann	6.5%
Autorefractor/keratometer	4.6%
Slit lamp	1.3%

OCT Technology & Principles

Types of OCT Technology

Time Domain OCT
~400 A-scans/second
Resolution: 10-15 microns

First-generation technology, technology, now largely replaced by faster modalities modalities

- Stratus OCT – Zeiss

Spectral Domain OCT
20,000-52,000 A-scans/second
Resolution: 3-5 microns

Current standard in clinical clinical practice with excellent image quality

- CIRRUS – ZEISS
- Spectralis – Heidelberg
- Optovue Solix / iVue80 – Visionix (formerly Optovue)
- Maestro2 – Topcon
- Canon Xephilio OCT-A1

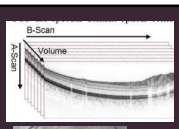
Swept Source OCT
1,00,000-4,00,000 A-scans/second
Wavelength: 1050-1060 nm

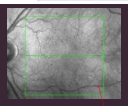
Superior tissue penetration through cataracts and hemorrhages

- Topcon DRI OCT Triton
- PLEX Elite 9000 – ZEISS
- Anterion – Heidelberg
- Casia SS-1000/ CASIA2 (Tomey)

Basics of OCT Imaging

- **How it Works:** The Principle of Interferometry
  - Utilizes light waves to scan retinal layers
  - Produces detailed, cross-sectional images of layers of retina
- **Applications:** Key tool in understanding both normal and pathological eye conditions.
  - Enables early diagnosis of pathology
    - Morphologic evaluation of live tissue
  - Provides high-resolution images to guide treatment decisions.

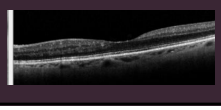




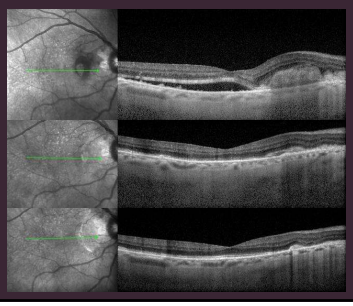
A-Scan Generation
Interference patterns produce axial A-scans measuring tissue depth

B-Scan Assembly
Multiple A-scans combine into 2D B-scan cross-sectional images

Examination is limited to this "block"... ..

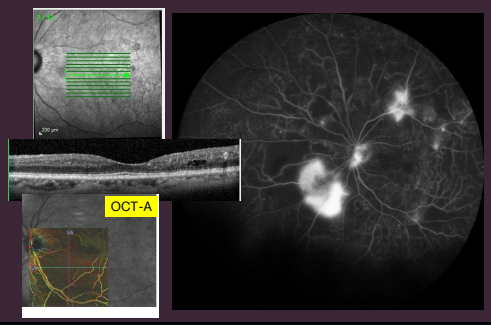


Advantage: High Resolution Cross Section Images



Allowing you to make appropriate clinical decisions when a suitable scan is obtained!

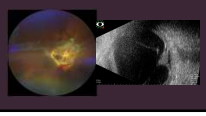
Disadvantage: Limited Scanned Area



OCT vs Other Imaging Modalities

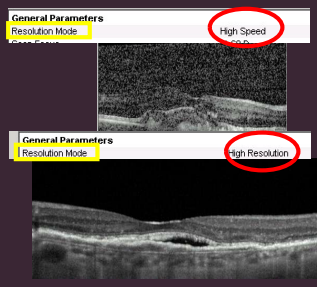
- **Uses:** Primarily used for documenting the appearance of the retina, optic nerve head, and macula.
- **Advantages:** Non-invasive, widely available, and cost-effective. Provides a broad view of the retina.
- **Disadvantages:** Limited depth information and less sensitive to subtle retinal changes compared to OCT.

- **Uses:** Maps the distribution of fluorophores in the retina, particularly useful for assessing retinal pigment epithelium health in diseases like AMD and retinal dystrophies.
- **Advantages:** Non-invasive, detects early retinal changes, and monitors disease progression.
- **Disadvantages:** Limited depth information and susceptible to artifacts from media opacities.



- **Advantages:** Effective for imaging the posterior segment in cases of media opacities, such as dense cataracts or vitreous hemorrhage.
- **Disadvantages:** Lower resolution compared to OCT and operator-dependent.

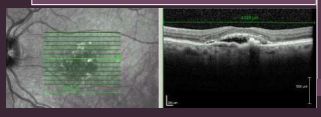
Image Acquisition: Speed vs. Resolution



Scan Protocols/Modes to Avoid Missing Pathology

Raster Scans

Raster scans involve a series of parallel lines that cover a rectangular area of the retina.

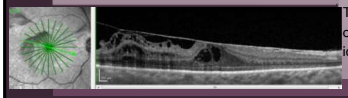


Clinical Indications: Useful for detailed mapping of retinal structures and are effective in detecting intraretinal and subretinal fluid, especially in conditions like diabetic macular edema and central serous chorioretinopathy.

Scan Protocols/Modes to Avoid Missing Pathology

Radial Scans

Radial scans consist of multiple lines radiating from a central point, typically covering the macula.

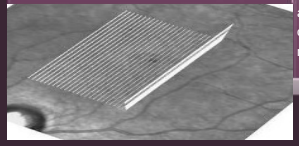


Clinical Indications: Effective for detecting macular holes and vitreomacular traction. They provide high-resolution images at the center of the scan, making them suitable for identifying focal pathologies.

Scan Protocols/Modes to Avoid Missing Pathology

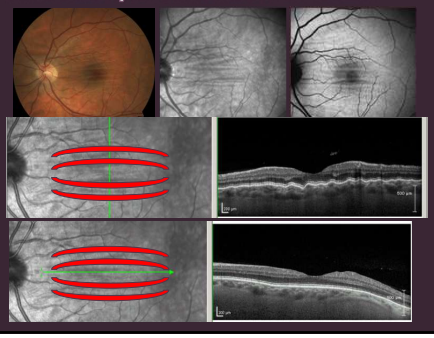
Cube Scans

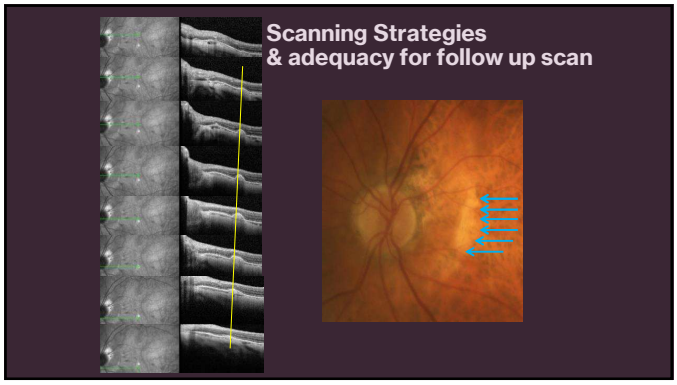
Cube scans involve a dense grid of lines that create a volumetric map of the retina.



Clinical Indications: Useful for comprehensive retinal analysis, including the assessment of retinal thickness and the detection of fluid in neovascular age-related macular degeneration (AMD).

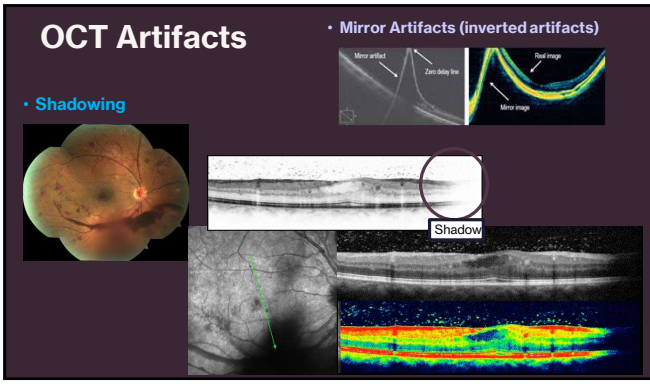
Direction/Orientation of Scan





OCT Artifacts

- Mirror Artifacts (inverted artifacts)
- Shadowing



Factors Affecting Scan Acquisition and Interpretation

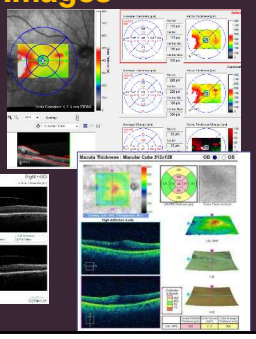
Eye Movement: Eye movement during scan acquisition can cause motion artifacts, leading to image blurring and misalignment.	**Troubleshooting:** Use eye tracking technology if available and instruct the patient to maintain steady fixation on the internal target.
Defocus: Defocus occurs when the OCT beam is not properly focused on the retina, resulting in blurred images.	**Troubleshooting:** Adjust the focus settings to ensure the retinal layers are clearly visible.
Decentration: Decentration happens when the scan is not centered on the area of interest, such as the macula or optic nerve head.	**Troubleshooting:** Realign the patient's eye and ensure the scan is centered on the target area.
Blink Artifacts: Blinks during scan acquisition can cause interruptions in the image.	**Troubleshooting:** Instruct the patient to blink before starting the scan and to keep their eyes open during the scan.

Key Takeaway: While OCT technology has revolutionized vitreous and choroidal imaging, optimal imaging, optimal results depend on proper technique, patient factors, and skilled interpretation by experienced clinicians.

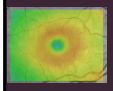
OCT Retinal Anatomy & Image Interpretation

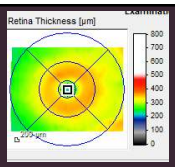
Interpretation of Data/Images

- Thickness Maps
- Actual Cross Sectional Images
  - ➢In plane view
  - ➢3D Modes
  - ➢Resolution Mode
- Color Scheme



Interpretation of Data: Topography/Thickness Maps



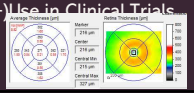


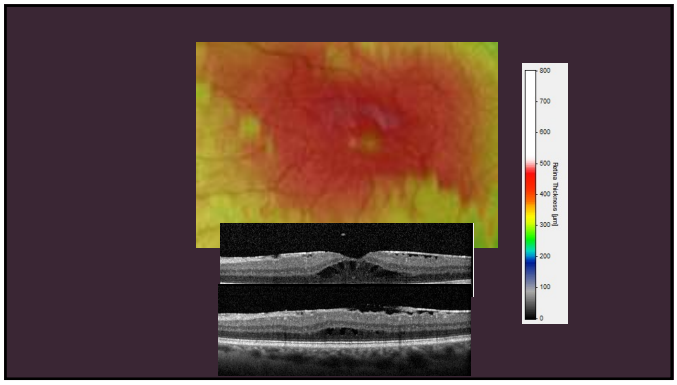
Pros

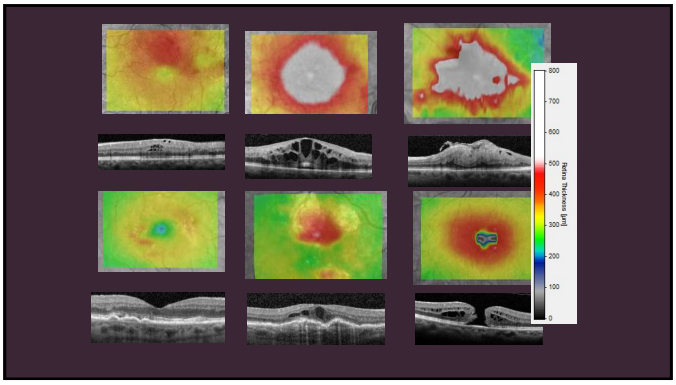
- (+)Ability to measure change over time
- (+)Overall assessment of an area in one glance
- (+)Use in Clinical Trials

Cons

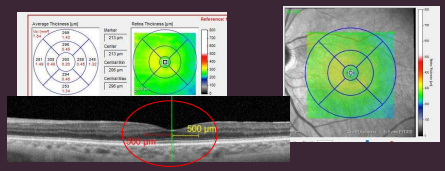
- (-)Inability to make specific diagnosis
- (-)If not compared to actual tissue, can lead to judgment errors
- (-)Relies on automated algorithms and tissue reflectance for results

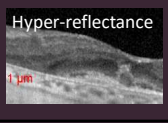


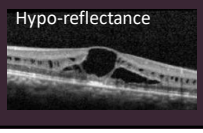




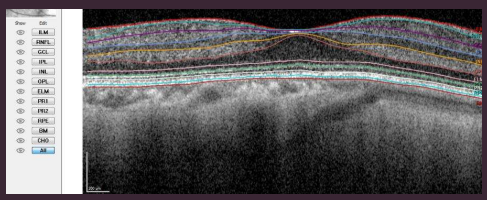
Interpreting Basic OCT Scans



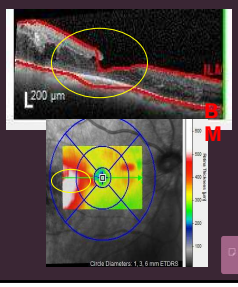




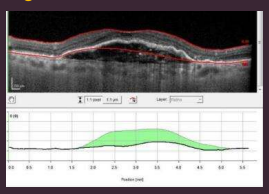
Segmentation



OCT Interpretation Errors

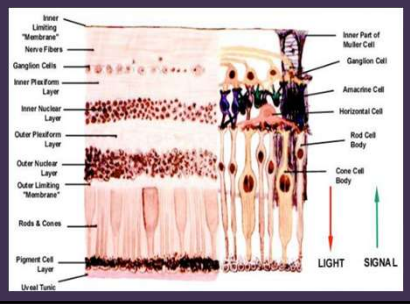


- **Segmentation Errors**



Best Practice: Always review raw OCT images alongside automated analysis reports to identify potential artifacts and ensure diagnostic accuracy

OCT Retinal Anatomy: Layer by Layer



LIGHT

SIGNAL

OCT Retinal Layer Visualization

10+ Distinct Identifiable Layers

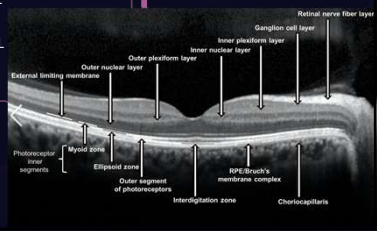
Inner Retina	Inner Limiting Membrane	Boundary between the retina and vitreous
	Nerve Fiber Layer	Contains axons of ganglion cells
	Ganglion Cell Layer	Cell bodies of ganglion cells
	Inner Plexiform Layer	Synapses between bipolar, amacrine, and ganglion cells
	Inner Nuclear Layer	Cell bodies of bipolar, horizontal, and amacrine cells
Outer Retina	Outer Plexiform Layer	Synapses between photoreceptors and bipolar/horizontal cells
	Outer Nuclear Layer	Cell bodies of photoreceptors (rods and cones)
	External Limiting Membrane	Junctional complexes between photoreceptors and Müller cells
	Photoreceptor Inner and Outer Segments	Where light is absorbed and converted to electrical signals
	Retinal Pigment Epithelium	Supports photoreceptors, absorbs stray light, and maintains the visual cycle

Visualization of Retinal Layers on OCT

Hyperreflective Layers
Bright on OCT imaging:
- RNFL
- IPL
- RPE

Hyporeflective Layers
Dark on OCT imaging:
- GCL
- INL
- ONL

Critical Landmarks
Key structures for assessment:
- Foveal depression (normal contour)
- Ellipsoid Zone (photoreceptor integrity marker)

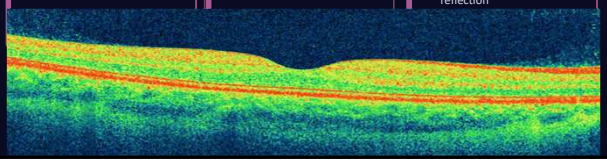


Visualization of Retinal Layers on OCT

High Reflectivity
Red/White signals:
- RNFL
- RPE

Intermediate Reflectivity
Green/Yellow signals:
- IPL
- OPL

Low Reflectivity
Blue/Black signals:
- Vitreous and fluid-filled spaces appear dark due to to minimal light reflection reflection



Color vs Monochrome


Colour versus grey-scale display of images on high-resolution spectral OCT

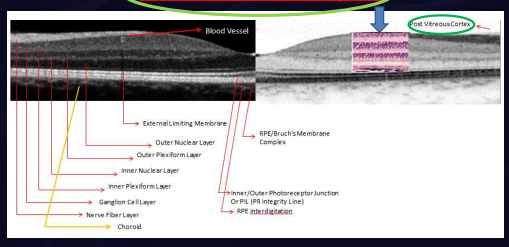
M Brar, D-U G Bartsch, N Nigam, F Mojana, L Gomez, L Cheng, J Hedaya, W R Freeman

PMID: 19211609 DOI: 10.1136/bjo.2008.146233

"**Conclusion:** Grey-scale images are qualitatively superior to the color-scale images on high-resolution spectral OCT. **Color images can be misleading**, as the displayed colors are false colors, and the observer may see a dramatic change in color and interpret that as a large change in the OCT reflectivity."

LIGHT

Vitreo-Retinal Interface



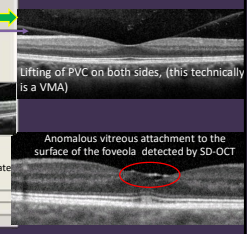
Vitreous Anatomy on OCT

Vitreous Appearance in OCT
- Appears as a dark, **hypo-reflective** area due to its low density and lack of reflective structures

Posterior Vitreous Cortex (PVC) Visibility

Posterior Hyaloid Membrane

Vitreoretinal Interface Importance
- The vitreoretinal interface is where the vitreous adheres to the retina; changes here indicate potential pathologies.

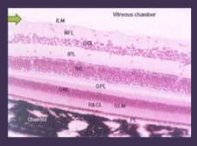


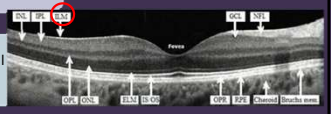
Inner Limiting Membrane (ILM)

ILM Anatomical Role
- The ILM forms the retina's innermost boundary and maintains its structural integrity.

ILM in OCT Imaging
- Appears as a thin, bright hyperreflective line at the retinal surface.

Clinical Significance
- ILM removal in epiretinal membrane surgery.





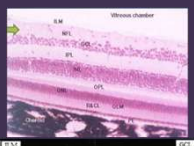
Nerve Fiber Layer (NFL)

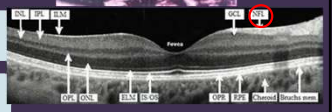
NFL Composition — Made of ganglion cell axons converging to form the optic nerve

OCT Visualization — Appears as a bright reflective band due to its **high reflectivity** compared to surrounding layers.

Clinical Importance — A key indicator in glaucoma diagnosis and monitoring disease progression through OCT measurement.

Measurement Significance — Accurate NFL thickness measurement is essential in managing optic neuropathies and assessing overall retinal health.

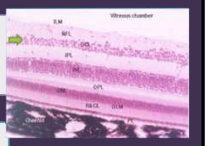


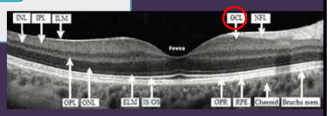


Ganglion Cell Layer (GCL)

Role of Ganglion Cells
- Ganglion cells convert graded potentials into action potentials for brain transmission.

OCT Appearance
- Appears as a **hyporeflective** layer



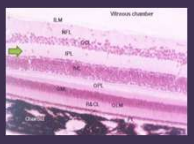


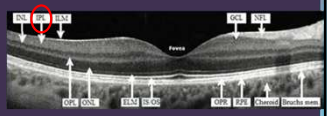
Inner Plexiform Layer (IPL)

Synaptic Connections — The site of synapses between bipolar, amacrine, and ganglion cells for visual processing.

OCT Appearance — Appears as a *moderately* **hyperreflective** band.

Impact of Pathologies — Diseases like diabetic retinopathy affect IPL structure





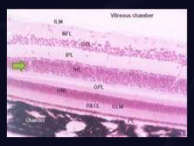
Inner Nuclear Layer (INL)

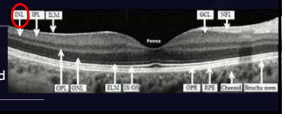
Cell Types in INL — Contains bipolar, horizontal, and amacrine cell bodies essential for retinal signal processing.

Function of INL Cells — These cells transmit and modulate signals from photoreceptors to ganglion cells.

OCT Appearance — Appears as a **hyporeflective** band.

INL in Retinal Diseases — INL changes appear in conditions like cystoid macular edema and retinal vein occlusion.



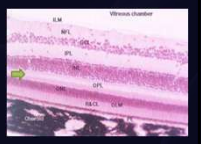


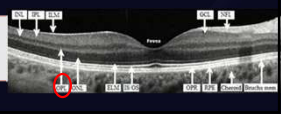
Outer Plexiform Layer (OPL)

OPL Synaptic Role
- Contains synapses connecting photoreceptors with bipolar and horizontal cells.

OCT Appearance
- Appears as a thin **hyporeflective** band located between the INL and ONL retinal layers.

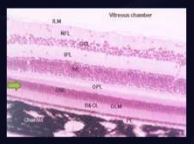
Disease Impact on OPL
- Diseases like macular telangiectasia and diabetic macular edema disrupt the OPL.

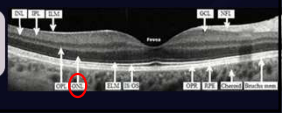




Outer Nuclear Layer (ONL)

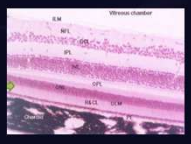
Structure and Function	• Contains photoreceptor cell bodies essential for capturing light
OCT Appearance	• Appears as a relatively hyporeflective band.
Disease Impact	• Degenerative diseases like retinitis pigmentosa affect the ONL, causing progressive vision loss.

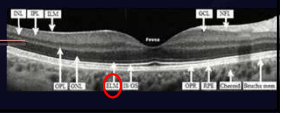




Outer/External Limiting Membrane

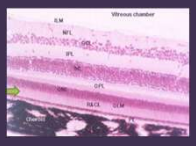
OLM Structure	A thin line formed by junctions between photoreceptors and Müller cells.
Barrier & Support Role	Acts as a barrier maintaining retinal structure and integrity.
OCT Appearance	Appears as a **hyperreflective** line just above the photoreceptor layer.
Clinical Significance	OLM disruption indicates photoreceptor damage in diseases like macular degeneration and dystrophies.

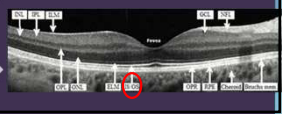




Photoreceptor Inner/Outer Segments (IS/OS)

Site of Phototransduction	Convert light into electrical signals essential for vision
Critical for Vision Quality	Support visual acuity and color perception
Biomarker in OCT Imaging	Serves as a key biomarker indicating photoreceptor health
Impact of Retinal Diseases	AMD and central serous retinopathy disrupt IS/OS layer causing vision loss





Retinal Pigment Epithelium (RPE)

RPE Functions

RPE absorbs stray light, recycles visual pigments, and maintains the blood-retina barrier.

OCT Appearance

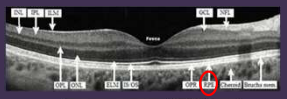
Appears as a **bright reflective band** on outermost layer in OCT retinal scans.

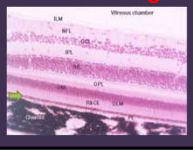
RPE in Disease

RPE is central in age-related macular degeneration and can detach in retinal disorders.

Clinical Imaging Role

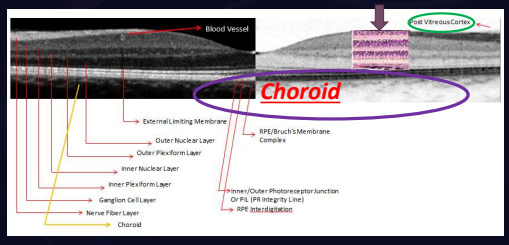
OCT imaging guides treatment by revealing RPE changes and subretinal fluid presence.



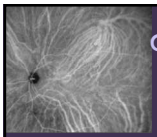


LIGHT

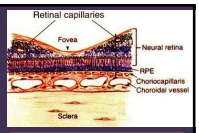
Vitreo-Retinal Interface



Choroidal Features on OCT



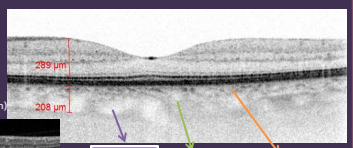
Vascular Anatomy



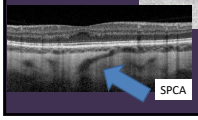
Vascular Architecture

Large choroidal vessels (Haller's layer) and medium vessels (Sattler's layer) appear as **hyporeflective** spaces surrounded by hyperreflective stromal tissue.

EDI
(Deeper Penetration)



Haller's | Sattler's | Choriocapillaris



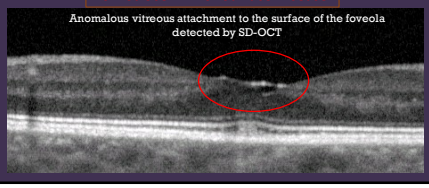
SPCA

EDI: Enhanced Depth Imaging
SPCA: Short Posterior Ciliary Artery

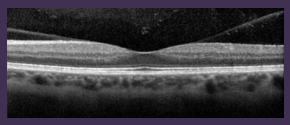
Vitreomacular Disorders

- Conditions caused by the vitreomacular interface and an anomalous posterior vitreous detachment (PVD)
- **Better understood since the advent and clinical utilization of SD-OCT**

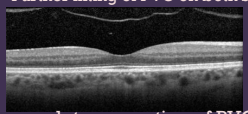
Do Not Use EDI for Surface Disease



Natural Progression of PVD at the VM Interface

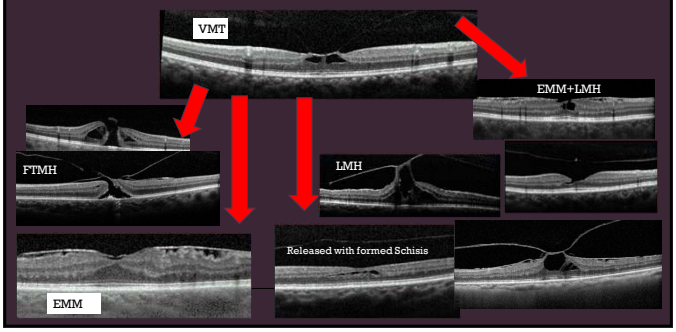


Further lifting of PVC on both sides, (This technically is a VMA)

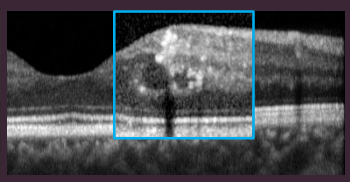


Finally complete separation of PVC form the perifoveal region, in this case there is still persistent partial attachment of the peripapillary PVC

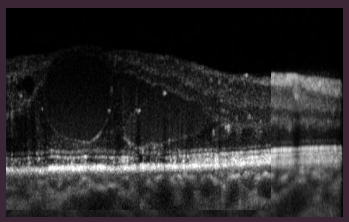
VMT Progression : Possible Outcomes



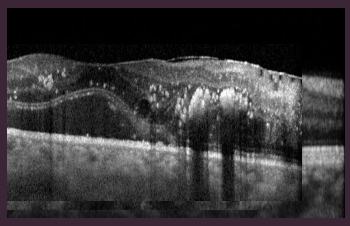
Disease Detection: Anatomy/Pathology



Diabetic Retinopathy

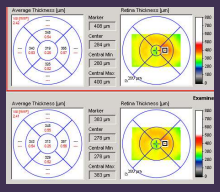


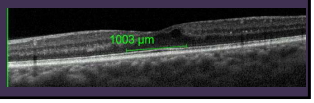
Diabetic Retinopathy Progression



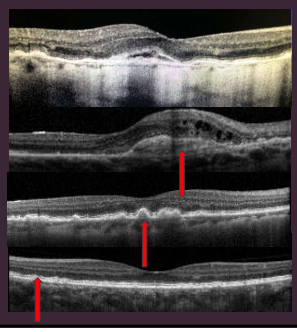
Classification of Diabetic Macular Edema (DME)

- OCT: most sensitive test
- **No DME:** No thickening, or exudates in the macula
- Center involved DME (ci-DME): Thickening within the 1 mm diameter
- Non-Center involved DME non-ciDME: Thickening outside of 1mm of fovea





Macular Degeneration Progression



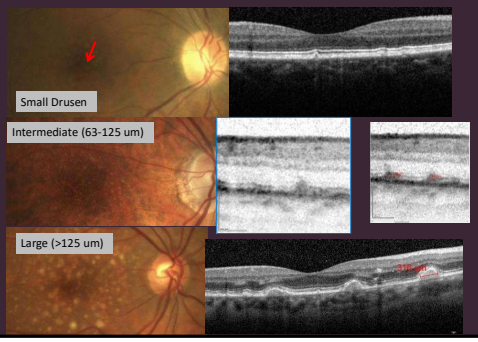
Concurrent GA & CNV

CNV

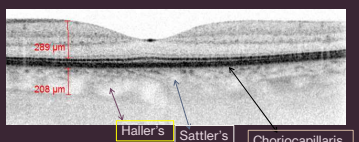
Intermediate AMD

Early AMD

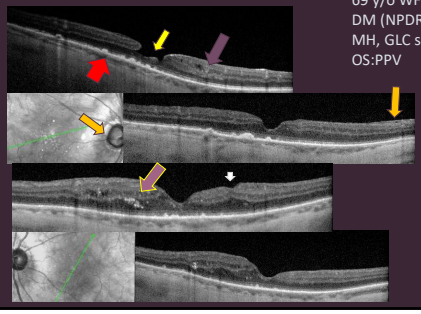
AMD



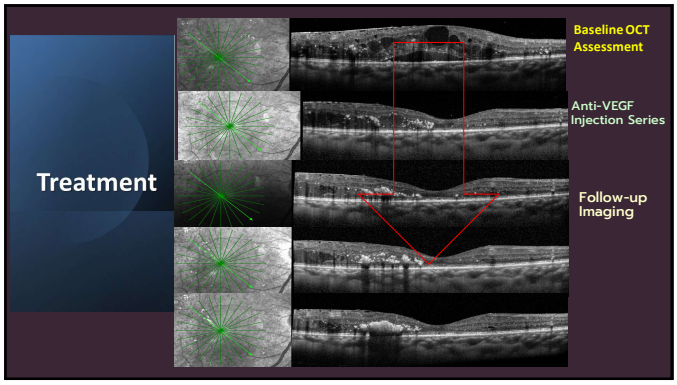
Choroidal Findings In AMD

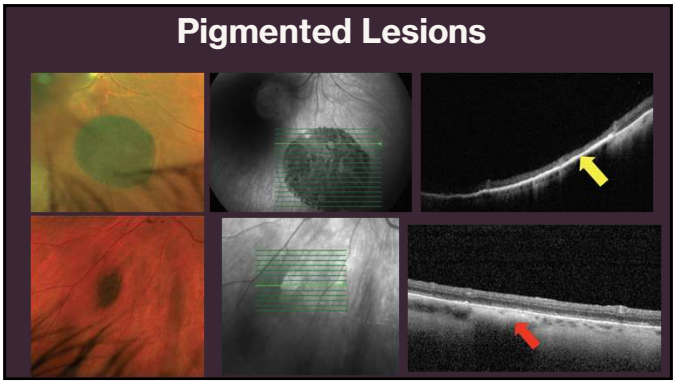


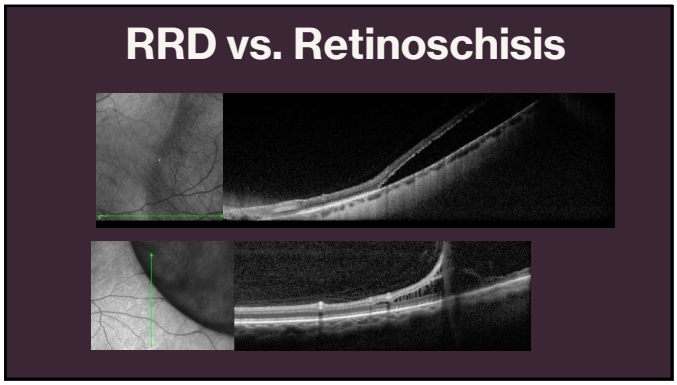
Multiple Pathologies



69 y/o WF
DM (NPDR), AMD,
MH, GLC suspect
OS:PPV

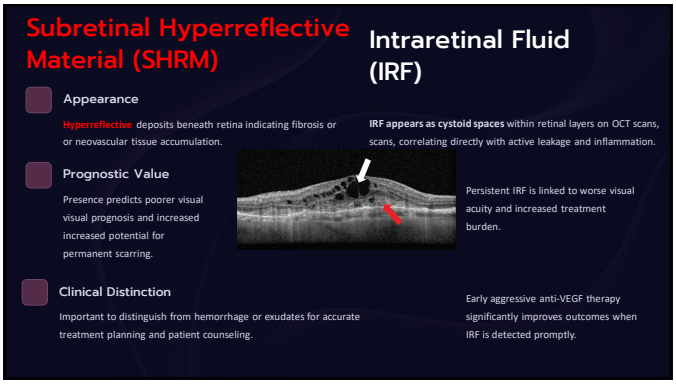

Treatment
Baseline OCT Assessment
Anti-VEGF Injection Series
Follow-up Imaging


Pigmented Lesions


RRD vs. Retinoschisis

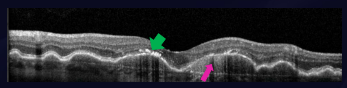

OCT Biomarkers

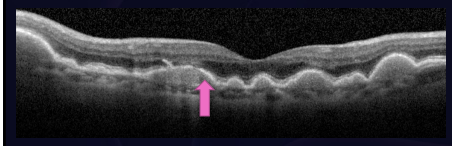

Why Biomarkers Matter
Early Detection
enable identification of of disease activity activity before clinical symptoms symptoms
Predictive Power
Predict visual outcomes and disease progression with increasing accuracy.
Personalized Treatment
Guide individualized treatment decision.

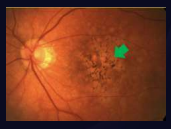

Subretinal Hyperreflective Material (SHRM)
Appearance
Hyperreflective deposits beneath retina indicating fibrosis or or neovascular tissue accumulation.
Prognostic Value
Presence predicts poorer visual visual prognosis and increased increased potential for permanent scarring.
Clinical Distinction
Important to distinguish from hemorrhage or exudates for accurate treatment planning and patient counseling.
Intraretinal Fluid (IRF)
IRF appears as cystoid spaces within retinal layers on OCT scans, scans, correlating directly with active leakage and inflammation.
Persistent IRF is linked to worse visual acuity and increased treatment burden.
Early aggressive anti-VEGF therapy significantly improves outcomes when IRF is detected promptly.

Pigment Epithelial Detachment (PED)

Elevation of RPE layer where height and reflectivity patterns help differentiate active versus quiescent lesions, guiding treatment intervals.



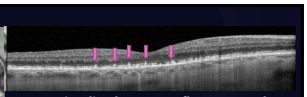




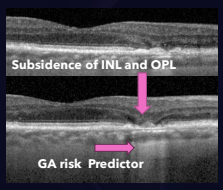
Monitoring PED morphology over time provides essential guidance for treatment planning and prognosis assessment.

Imaging Features Associated with Progression to Geographic Atrophy in Age-Related Macular Degeneration

Classification of Atrophy Meeting Report 5

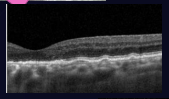


RPD visualized on NIR Reflectance, and OCT Presents a Risk Factor for GA



Subsidence of INL and OPL

GA risk Predictor

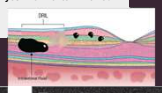


Double-Layer Sign (DLS)
GA to CNV risk predictor

Disorganization of Retinal Inner Layers (DRIL)

From: **Disorganization of the Retinal Inner Layers as a Predictor of Visual Acuity in Eyes With Center-Involved Diabetic Macular Edema**

JAMA Ophthalmol. 2014;132(11):1309-1316. doi:10.1001/jamaophthalmol.2014.2350



What is DRIL?

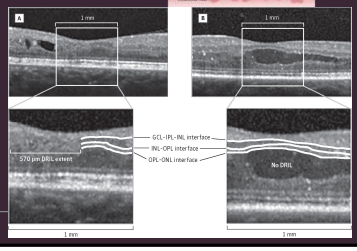
Loss of clear boundaries between ganglion cell, inner inner plexiform, inner nuclear, and outer plexiform layers. layers.

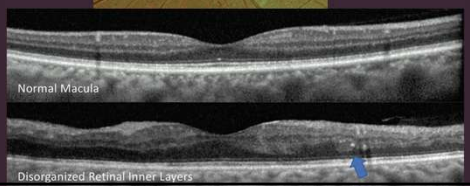
Visual Correlation

Extent of DRIL correlates strongly with visual acuity impairment in diabetic patients.

Prognostic Significance

Increasing DRIL over time predicts worsening vision vision despite treatment, indicating irreversible neural neural damage.





Hyperreflective Retinal Foci (HRF)

Appearance

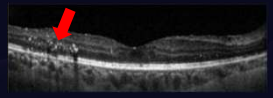
Small, punctate hyperreflective spots representing lipid extravasation or inflammatory cells within retinal tissue.

Clinical Correlation

Number and size of HRF correlate with retinal inflammation severity and disease activity.

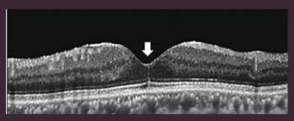
Treatment Response

HRF reduction after corticosteroid or anti-VEGF therapy indicates positive positive treatment response and inflammation control.



Foveal Crack Sign (FCS)

- Appears on OCT as a vertical, **hyperreflective** line in the foveola.
- Associated with macular hole formation following PPV for rhegmatogenous retinal detachment.
- Patients should be followed closer and longer following RD repair



Clinical Applications of OCT

Initial Presentation

October 2019

Patient Profile

- 67-year-old Caucasian female
- PCP referral for baseline evaluation
- No visual complaints reported

Medical Background

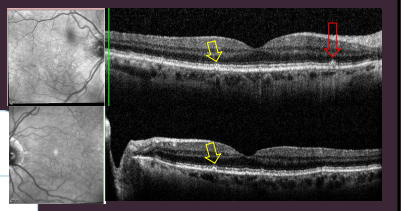
Systemic: Controlled hypertension, sleep apnea (CPAP compliant)

Ocular: Unremarkable history, no prior interventions

Baseline Clinical Findings

October 2019 Examination

1. **Visual Acuity**
   BCVA: 20/30 OD, 20/40 OS
   Corrected to 20/25 OU
2. **Anterior Segment**
   Early nuclear sclerotic cataracts OU
   Mild meibomian gland dysfunction
3. **Posterior Segment**
   Hypertensive retinopathy changes
   Small, scattered drusen with RPE alterations OU



Early AMD confirmed bilaterally — baseline documentation/imaging established

Critical Gap: Patient lost to follow-up × 46 months due to COVID-19 pandemic concerns

Return Visit

August 2023 – Nearly 4 Years Later

Chief Complaint

"Worsening vision in my right eye — things look distorted and dim"

Visual Acuity

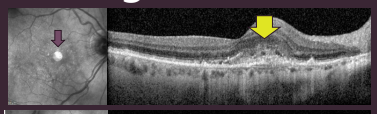
BCVA: **20/60 OD** (↓2 lines), **20/30 OS** (stable)

Significant decline in right eye function — immediate advanced imaging indicated

Bilateral AMD Progression

August 2023 —

OD: Wet AMD



OS: Geographic Atrophy

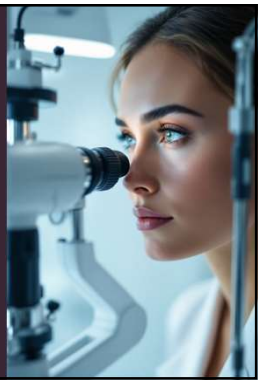
NIR images (left) the blue arrow labels image artifact. The hyperreflective areas nasal to fovea (red arrows) are small GA lesions typically seen this way on NIR). OCT of the right eye (top) shows an elevated subretinal lesion with associated fluid indicative of MNV. The left eye (bottom) shows a cross-section of one of the GA lesions, the outer retina subsidence (white arrow), and choroidal hypertransmission typical of GA lesions.

OCT DDX: Case Study

15-Year-Old Black Male

Chief Complaint

Pain, vision loss, and "bloody eye" appearance in left eye with nerf gun. No prior pertinent medical or ocular history documented.



Summary of Findings

Right Eye

- VA: 20/20
- IOP: 12 mmHg
- Pupil, EOM, confrontation: Normal
- Anterior segment: Normal
- Posterior segment: Normal

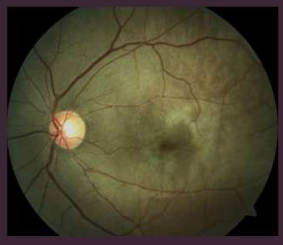
Left Eye

- VA: 20/400
- IOP: 8 mmHg (hypotony)
- **Pupil: Round but sluggish reactivity**
- EOM: Normal, no orbital injury signs
- Confrontation: Limited by discomfort

Anterior Segment Detail

❑Examination complicated by patient discomfort
❑Lids: Ecchymosis LL
❑Conjunctiva: Subconjunctival Hemorrhage
❑Cornea: Clear
❑A/C: DEEP *(what if it was shallow)* 1+ Cell and Flare, no Hyphema
❑Lens: (post dilation) Clear

Fundus Examination



Key Findings

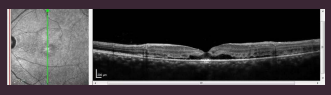
- **Optic Disc:** Appears normal without edema or pallor
- **Macula:** Reddish discoloration noted centrally
- **Posterior Pole:** Diffuse whitening consistent with commotio retinae
- **Periphery:** Difficult examination, retina appears attached with no visible tears, breaks, or hemorrhages

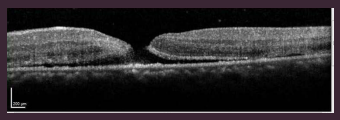
OCT Imaging Reveals Extensive Damage

Traumatic Macular Hole
Full-thickness disruption of foveal architecture visible on cross-sectional imaging

Retinal Disorganization
Outer and Intraretinal Disorganization

Subretinal Fluid





Diagnosis

Anterior Segment Trauma
Traumatic ecchymosis, subconjunctival hemorrhage, and iritis

Posterior Segment Injury
Commotio retinae, and traumatic full-thickness macular hole

Initial Treatment Protocol

1. Topical Cycloplegic Agent
   Reduces ciliary spasm and provides symptomatic pain relief
2. Topical Corticosteroid
   Controls anterior chamber inflammation and reduces inflammatory sequelae
3. Monitor Retinal Findings
   Serial observation of macular hole and peripheral retina for progression or complications
4. Follow-up Schedule
   Return examination in 1 week to assess therapeutic response and disease evolution

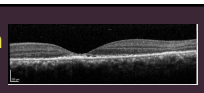
10 Days Later: Follow-Up Examination

Clinical Status

- **VA:** 20/200 (improved from 20/400)
- **IOP:** 12 mmHg
- **Anterior segment:** Inflammatory findings resolving appropriately

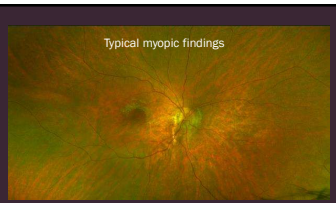
Fundus Findings

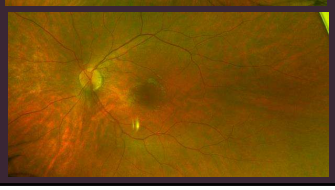
- Complete resolution of commotio retinae
- Spontaneous closure of traumatic macular hole
- **Significant, permanent outer retinal atrophy** with irreparable photoreceptor damage



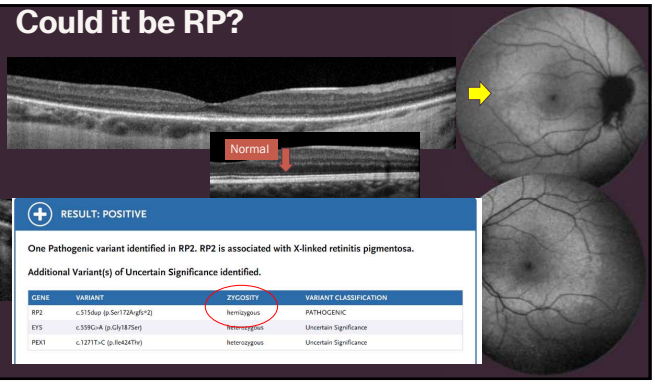
❑ Despite anatomic hole closure, the extensive outer retinal atrophy indicates permanent visual impairment with limited recovery potential.

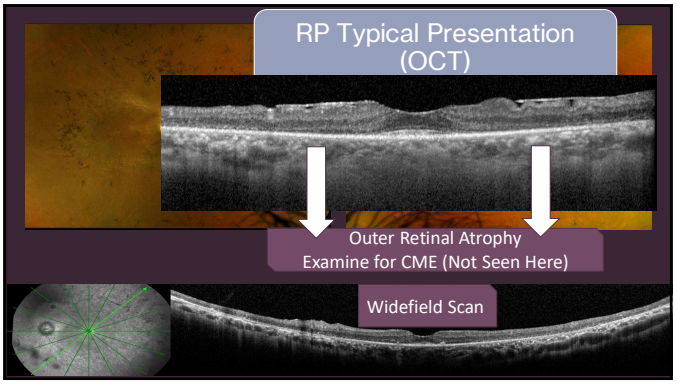
- 11 y/o WM referred for reduced vision and concerns of RP due to family history
- 20/70 high myope (OD>OS)



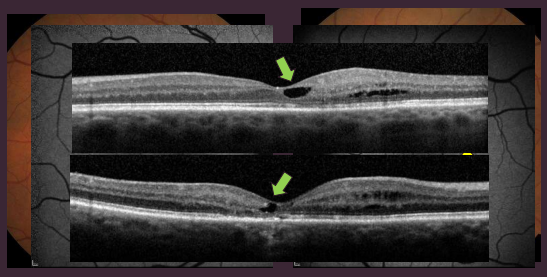


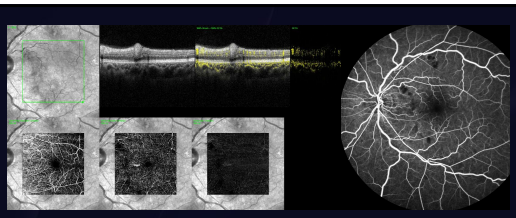
Could it be RP?





62 y/o WF – referred for decreased vision, possible macular hole





OCT Angiography (OCTA) – Vascular Imaging Without Dye

Optical Coherence Tomography Angiography

OCTA provides non-invasive visualization of retinal and choroidal microvasculature without the need for dye injection.

Layer-Specific Capillary Networks

Separate visualization of superficial, deep, and choriocapillaris choriocapillaris vascular plexuses for detailed assessment of perfusion status

Key Applications

- Detects vascular abnormalities in diabetic retinopathy
- Identifies neovascularization in AMD
- Assesses retinal vein occlusion perfusion defects

OCT vs OCT-A Imaging

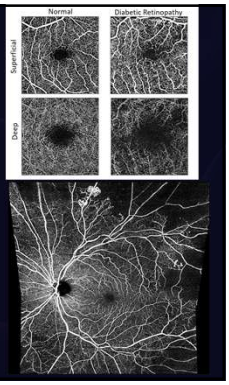
Traditional OCT reveals structural anatomy, while OCTA adds dynamic vascular flow information, information, creating a comprehensive view of retinal health.

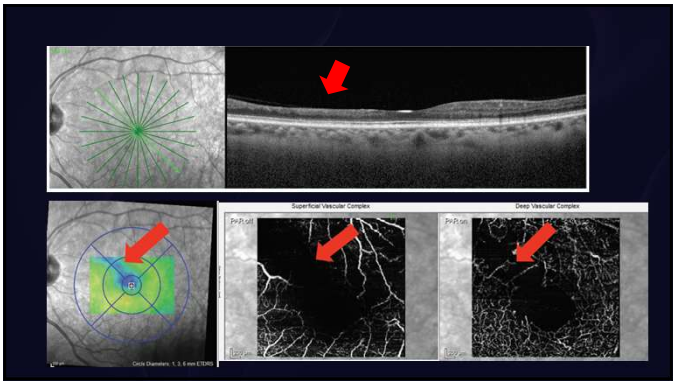
Clinical Applications of OCT-A

Diabetic Retinopathy (DR)

OCTA detects capillary nonperfusion and microvascular abnormalities

- Visualizes enlarged foveal avascular zone (FAZ) indicating ischemia
- Identifies neovascularization and microaneurysms with precision
- Enables early detection of ischemic changes
- Guides treatment decisions and monitors therapeutic response



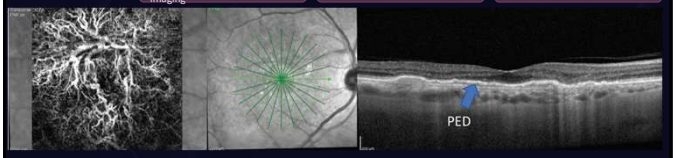


AMD

Neovascularization Detection
Identifies and characterizes macular neovascularization (MNV), including challenging challenging type 1 sub-RPE lesions that are difficult to visualize with traditional imaging

Activity Assessment
Differentiates active from quiescent neovascular membranes based on vascular morphology and flow characteristics

Treatment Monitoring
Monitors response to anti-VEGF therapy noninvasively, reducing injection burden and improving patient outcomes



Challenges and Considerations

1 — Interpretation Pitfalls
Artifacts from eye movement, poor fixation, and media opacities can mimic pathology. Segmentation errors may produce misleading thickness measurements.

2 — Normative Database Limitations
Standard reference databases may not account for ethnic variations, high myopia, or anatomical variants—requiring careful requiring careful interpretation in diverse populations.

3 — Clinical Correlation Essential
OCT findings must always be interpreted within the complete complete clinical context including symptoms, visual function, function, and other examination findings.

4 — Interprofessional Collaboration
Complex cases benefit from collaboration between optometrists, optometrists, ophthalmologists, and retina specialists to optimize optimize diagnostic accuracy and treatment planning.

Emerging Innovations and Future Directions

Handheld OCT Devices/ Home OCT Monitoring

Portability Revolution | Remote Monitoring | Pediatric/ Geriatric/ Hospital Applications

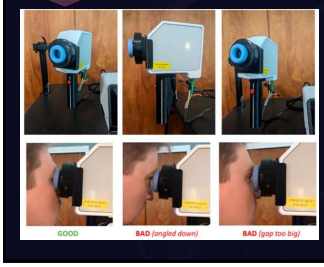
AI-Assisted Analysis
Sophisticated algorithms provide automated image quality assessment and and preliminary interpretation

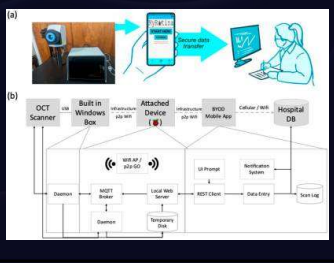
Secure Remote Transfer
HIPAA-compliant cloud platforms enable instant, secure data transmission to transmission to physicians

Frequent Monitoring
Facilitates near-daily monitoring for diseases like neovascular AMD, enabling enabling proactive treatment adjustments

Community-Based OCT Imaging: The New Frontier

Devices like SightSync OCT enable technician-free retinal imaging in community settings





Intraoperative OCT: Real-Time Surgical Guidance

Surgical Precision Enhancement

Real-time OCT imaging during vitreoretinal surgery provides provides unprecedented visualization, enhancing surgical surgical precision and improving patient outcomes.

Key Surgical Applications

- Guides epiretinal and internal limiting membrane peeling
- Confirms complete retinal reattachment during repair
- Optimizes implant positioning accuracy
- Identifies residual pathology requiring additional intervention

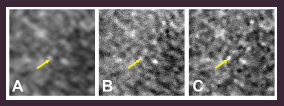
Game Changer: Real-time feedback during surgery enables immediate decision-making and improved outcomes

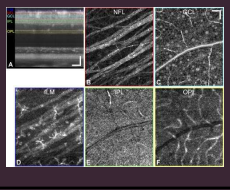
Microscope-integrated systems provide surgeons with cross-sectional views without interrupting surgical flow, representing a paradigm shift in vitreoretinal surgery.

Adaptive Optics in Retinal Imaging

Breaking the Resolution Barrier

- **How It Works**
  - Measures optical aberrations
  - Compensates for distortions
  - Enables cellular-level resolution
- **Unprecedented Resolution**
  - Individual photoreceptor visualization
  - Retinal capillary detail
  - RPE cell mosaic imaging
  - Individual nerve fiber bundles



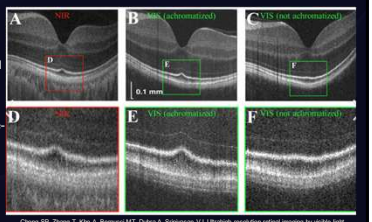


Ultra-High-Resolution OCT (UHR-OCT)

- Enables micron-scale cross-sectional or 3D imaging of a subject.
- It is relevant for various applications, from analysis of tissue in medical applications to visualization of sub-micron structures in manufacturing.

Visible Light OCT

- Leverages visible light instead of near-infrared light to achieve high-resolution imaging of biological tissues.
- Key Advantages
  - High Resolution: vis-OCT can achieve one-micron level axial resolution, which is superior to many near-infrared OCT systems.



Chong SP, Zhang T, Kho A, Bernucci MT, Dubra A, Srinivasan VJ. Ultrahigh resolution retinal imaging by visible light OCT with longitudinal achromatization. Biomed Opt Express. 2018 Mar 5;9(4):1477-1491. doi: 10.1364/BOE.9.001477. PMID: 29675296; PMCID: PMC5905900.

Functional Imaging OCT

Retinal Oximetry

- Measures blood oxygen saturation at the capillary level capillary level noninvasively, revealing metabolic health

Optoretinography

- Emerging ORG technology assesses individual photoreceptor function directly, opening new frontiers in diagnosis.

Artificial Intelligence & Automated Analysis

Enhanced Detection

AI algorithms analyze OCT scans with superhuman speed and consistency, improving detection accuracy while reducing clinician workload and interpretation variability.

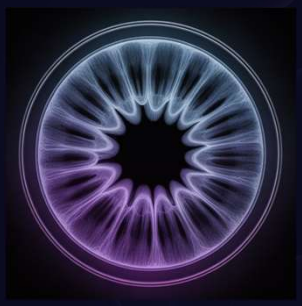
Predictive Analytics

Machine learning models predict disease progression trajectories, enabling proactive intervention and personalized treatment planning based on individual risk profiles.

Clinical Decision Support

AI-powered systems provide evidence-based treatment recommendations, flag urgent findings requiring immediate attention, and identify subtle patterns invisible to human observers.

OCT in Neurodegenerative and Systemic Diseases



The Eye as a Window to the Brain

Retinal nerve fiber layer thinning detected by OCT
OCT has been definitively linked to mitochondrial mitochondrial dysfunction and neurodegenerative neurodegenerative diseases.

Promising Biomarker

OCT measurements show remarkable potential as an accessible, noninvasive noninvasive biomarker for early diagnosis of conditions including Parkinson's disease, Parkinson's disease, Alzheimer's disease, and multiple sclerosis—often detecting detecting changes years before systemic symptoms emerge.

Condition	OCT Angiography Findings
Healthy control	Clear depiction of retinal and choroidal layers, even blood blow in both deep and superficial vascular plexuses
Multiple Sclerosis	Decreased blood flow to optic nerve head and parafoveal region of retina
Alzheimer's Disease	Decreased blood flow to retinal cells (specifically ganglion cell layer)
Parkinson's disease	Controversial findings, some studies suggest diminished microvascular density of retinal cells (specifically the superficial vascular retinal layer) and thinning of inner plexiform and ganglion cells.

The Future of OCT in Eye Care

AI Integration
Fully automated interpretation and predictive modeling

Portable Devices
Smartphone-compatible OCT for global accessibility

Multi-Modal Fusion
Integration with genomics and systemic health data

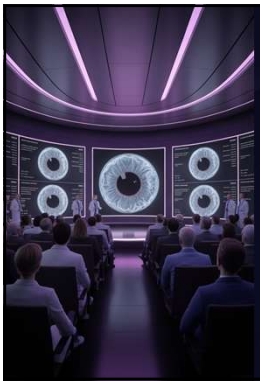
Personalized Medicine
Treatment algorithms tailored to individual disease signatures

Conclusion: Harnessing OCT for Superior Patient Care

Indispensable Technology
OCT has become essential for modern eye care, offering unparalleled insight into ocular ocular health that was impossible impossible just decades ago.

Continuous Innovation
Staying current with technological technological advances—from from OCTA to AI integration—integration—maximizes diagnostic diagnostic and therapeutic potential for your patients.

Practice Transformation
Empower your practice with OCT OCT to improve early detection, detection, monitor progression progression with precision, and and guide personalized treatment treatment decisions.



Thank You!

Questions ?