DIAGNOSTIC TESTING

WHAT OPTICIANS AND TECHNICIANS NEED TO KNOW TO GET THE BEST RESULTS

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Vision Expo West
Las Vegas, NV
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On behalf of Vision Expo, we sincerely thank you for being with us this year.

Vision Expo Has Gone Green!

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Conference Advisory Board considers content and speakers for future meetings to provide you with the best education possible.

VISION EXPO

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FINANCIAL DISCLOSURES

Shana Barrett Zeitlin, O.D. has no financial interests to disclose.

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OUTLINE

- Basic ocular anatomy
- Posterior and anterior segment OCT
- Fundus photography
- Visual field testing
- Amsler, stereo, and color vision testing

- Goals:
  - Understand the technology as it relates to anatomy and pathology
  - Pick up tips for getting the best scans and test results
  - View examples of ocular disease scans
  - Learn to explain rationale and importance of testing

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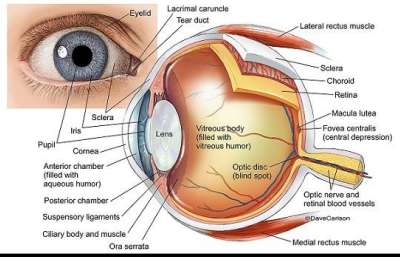
OCULAR ANATOMY



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OCT: OPTICAL COHERENCE TOMOGRAPHY

- Uses laser light to visualize and map the different layers of the retina, optic nerve, and anterior segment structures
- A camera-like device directs the waves of light, which bounce back with a 2-D or 3-D picture
- Non-invasive, not destructive to tissue
- Multiple models and brands
  - Zeiss: Cirrus, Visante
  - Optovue: iVue, iScan, Avanti
  - Heidelberg: Spectralis
- Anterior and posterior segment capability

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COMMON OCT ABBREVIATIONS

A-Scan/B-Scan: Axial images allowing for 3D representation/line scan of longitudinal images

Deviation Map: Graph comparing patients' deviation to normative age-matched database

EDTRS: Early Treatment Diabetic Retinopathy Study

En face OCT: View of retina or optic nerve as a clinician would view during funduscopy

GCL/GCA/GCC: Ganglion cell layer/ganglion cell analysis/ganglion cell complex

GCL-IPL: Ganglion cell layer-inner plexiform layer

Line Scan: Scan through a tissue which can be adjusted to orientation

ONH: Optic nerve head

Raster: Scan generally consisting of five lines that can have various spacing and orientation (customizable)

RNFL/pRNFL: Retinal nerve fiber layer/peripapillary retinal nerve fiber layer

SD-OCT: Spectral-domain optical coherence tomography

Thickness Map: Graph comparing retinal thickness to normative age-matched database

Tomogram: A two-dimensional image of a slice through a tissue (i.e., retinal tissue)

TSNIT: Linear graph of concentric nerve fiber layer thickness in respect to normative database

Volume Scan: 3D representation formed from the vertical & horizontal line scans, representing a block or cube of retinal tissue

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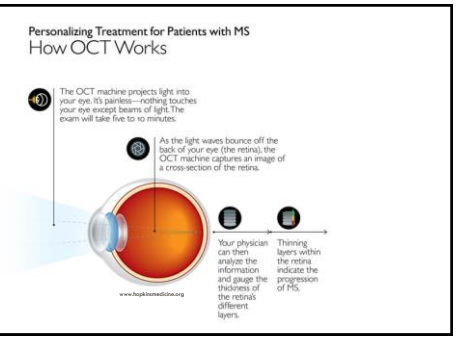

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OCT: GENERAL TIPS

- Clean the lens thoroughly between patients.
- Dilation will often improve signal strength, image quality and the fundus image.
- To improve patient fixation and reduce distraction, patch the fellow eye, particularly in patients with poor vision or when scanning the optic nerve head or retinal nerve fiber layer.
- Instruct patients to close eyes between each acquisition of scans to keep the corneal surface lubricated.
- Use artificial tears with dry eye patients.
- Use an assistant to help with head fixation and support in cognitively impaired and physically disabled patients. Use the Fast Scan, if your machine has this capability.

https://www.aao.org/eyenet/article/oct-getting-best-images

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OCT: GENERAL TIPS

- Adjust table height for wheelchair patients and perform the scan with the patient in the wheelchair.
- When focusing the scan, the patient should be instructed where to fixate and to "keep teeth together, chin down and head still."
- Patients with nystagmus
  - Try to time the acquisition to a null point in the nystagmus
  - May have to use techniques like physically turning the patient in a particular direction
- No matter how good you are…. **You can't create clarity where there is none!**
  - Sometimes the image quality isn't good (ex. Dense cataract), but we can still see the presence or absence of findings like macular fluid or drusen

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OCT ARTIFACTS

Centration: The image is not centered in the grid used to calculate thickness of tissue.
- Especially important in monitoring thickness over time in response to therapy

Blink: When the patient blinks during scanning, blank areas are displayed by default in the en face images, and B-scans lose retinal data.

Shadow: A variety of factors such as floaters can cast a shadow and result in a low signal

Mirror: The OCT generates two images, one a mirror image of the other.
- If the scan is not placed properly within the box, or if the person being scanned is very myopic (and the retina is very curved), you'll see that mirror artifact.

The edge of the scan is cut off: In this situation the data is incomplete because the scan is incomplete, most likely because the patient moved during the scan. The problem is that the machine will give you a measurement for the rest of the scan anyway.
- Need to repeat the scan while the patient is still in the chair

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OCT: MACULA

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OCT: MACULA USES

AMD: age-related macular degeneration
CNV: choroidal neovascularization
PED: pigment epithelilal detachment
ERM: epiretinal membrane
CSR: central serous retinopathy
Macular hole: pseudo, lamellar, full-thickness
VMT: vitreomacular traction
CME: cystoid macular edema

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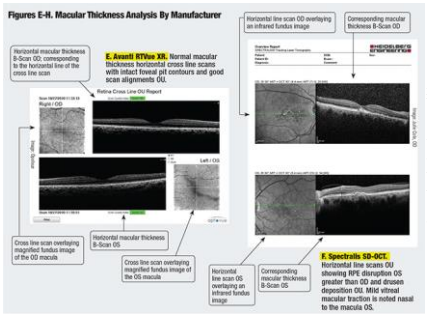

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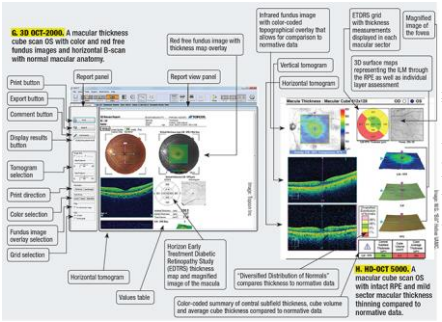

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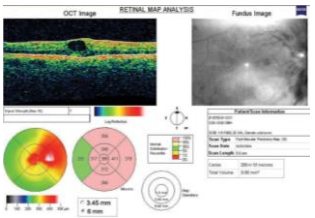
MACULA TIPS

- For pathologies such as macular hole, pigment epithelial detachment or epiretinal membrane, a clinician might not be as concerned with thickness mapping as with obtaining a high-resolution image.
- The standard Macula Scan, Line Scan or Cross-Hair Scan can all be used to obtain high-resolution cross-sectional images of the area of interest.



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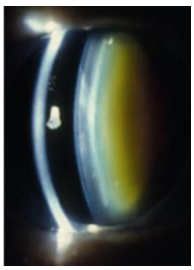
MACULA TIPS

- For some retinal conditions, the automated analysis may fail, but the **cross-sectional images are still valid** and are critical for diagnosis and patient management.
  - Macular holes (lamellar or full-thickness holes)
  - AMD
  - Subretinal fluid formation
- High refractive error px: use the corrective wheel or tab to input minus or plus into the machine to correct for the error
  - Obtain better focus more quickly.



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MACULA TIPS

- To image macular holes, instruct the patient to look at the fixation point and "make it disappear." The fixation point will seem to disappear to the patient when it is projected into the macular hole. Obtain the image when the fixation point disappears into the macular hole.
- Use the Move Scan/Landmark function to image the fovea in patients with fixation problems and central scotoma (such as AMD patients).
  - Optovue has a flexible fixation stick outside the machine to get fellow eye fixation
- For patients with central scotoma, instruct patient to look "in the center" of the circular alignment scan.
  - Also "make the image disappear"

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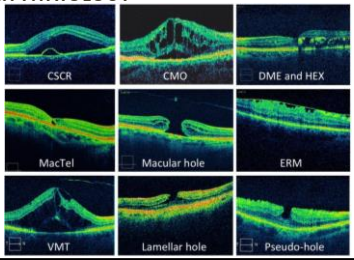
MACULA PATHOLOGY



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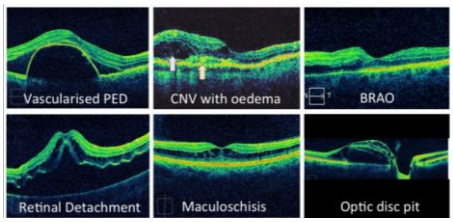
MACULA PATHOLOGY



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OCT: OPTIC NERVE

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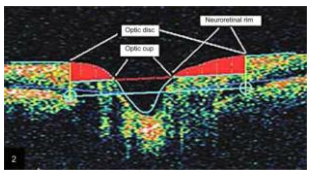
OCT: OPTIC NERVE USES

- Glaucoma
  - Open angle, pre-perimetric, NTG
- Multiple sclerosis
  - Acute neuropathy
- Toxic optic neuropathy
- AION
- Papilledema
- Optic nerve compression
- ONH drusen



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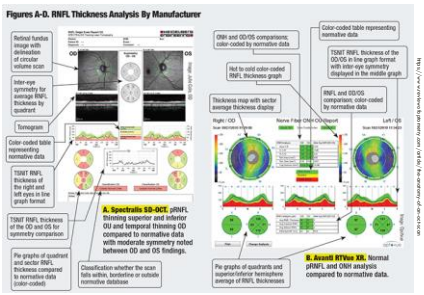

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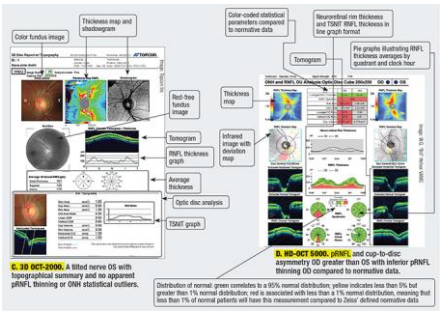

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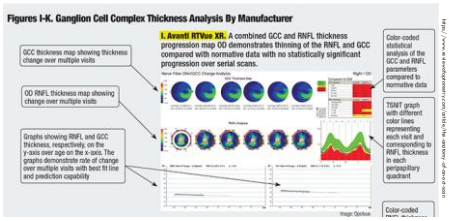

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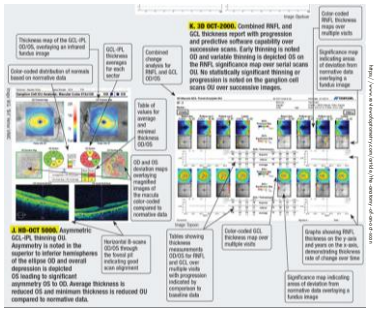

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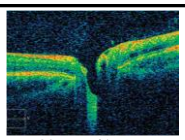
OPTIC NERVE TIPS

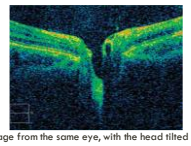
The strength of the reflected light measured in OCT is dependent on small changes in the refractive index of the tissue, and the orientation of the structure under investigation relative to the incident beam

A poor signal is often responsible for underestimation of the RNFL thickness

Changes in the position of the head, and therefore in the orientation of the axis of the eye, can lead to variable results



OCT image of the RNFL, with correct head positioning.



OCT image from the same eye, with the head tilted back. The apparent thickness of the RNFL is reduced.

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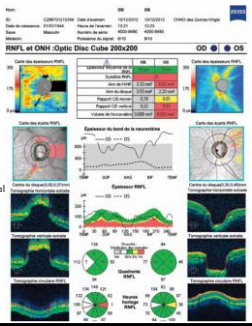

OCT image from a patient who was incorrectly positioned for examination of the right eye.

The image touches the upper part of the black frames, and all retinal structures appear inverted.

The left eye is correctly positioned and gives a clear picture.

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OPTIC NERVE TIPS: EYE MOVEMENT

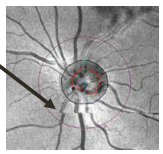
Changes in eye movements can contribute to poor quality images

Can be detected by misalignment of retinal blood vessels in the produced image

The eye typically has five microsaccades per second, so unless there is image tracking, motion artifact is very likely even with the most cooperative patient

Can be due to:

- Ocular saccades
- Change of head position
- Respiratory movements



Discontinuity of the image due to eye movement during examination. This can contribute to errors in the measurement of RNFL thickness.

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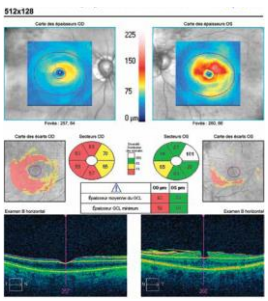
GANGLION CELL

Macular edema can falsely indicate "healthy" GCL

OCT images from a patient with bilateral glaucoma, with visual impairment skimming the central 10°.

The right hand image shows damage to the ganglion cell complex (arrow), while the left hand image shows a macular hole. Traction at this level, and the resulting edema, are masking the thinning of the RNFL, which appears to be normal.



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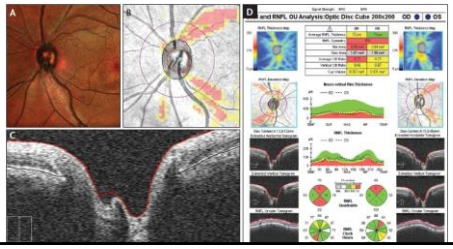
GLAUCOMA



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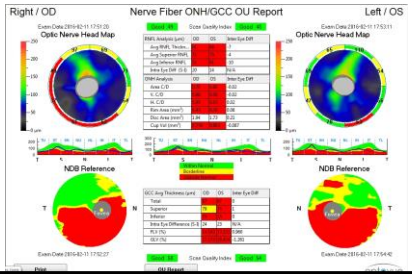
GLAUCOMA



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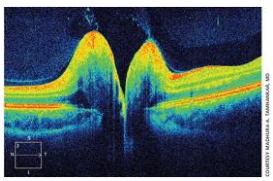
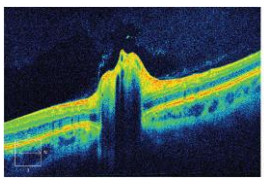
PAPILLEDEMA VS. ONH DRUSEN



True papilledema: smooth inner contour
Papilledema is swelling of the optic nerve head due to increased intracranial pressure.



Pseudopapilledema: "lumpy bumpy" internal contour
Pseudopapilledema is a benign condition in which elevation of the optic nerve head is observed in the absence of intracranial structural abnormalities.

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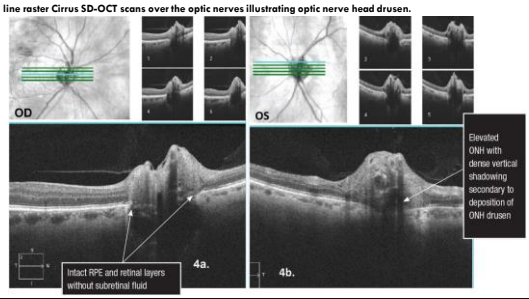
5 line raster Cirrus SD-OCT scans over the optic nerves illustrating optic nerve head drusen.



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OCT: ANTERIOR SEGMENT

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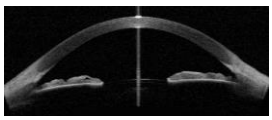
OCT: ANTERIOR SEGMENT USES

- Anterior segment angle
  - Glaucoma
  - Narrow and closed angles
  - Evaluation s/p iridotomy and cataract sx
  - Iris abnormalities
- Cornea
  - Pachymetry
  - Keratoconus*
  - LASIK
- Contact lenses
  - Scleral CL fits



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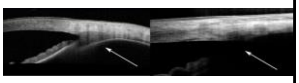
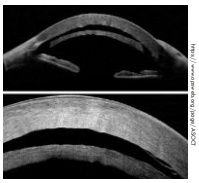
OCT: ANTERIOR SEGMENT



- Visante vs. iVue
  - Visante (TD-OCT) has the ability to image the ciliary body and pathology shadowed by the iris better than SD-OCTs
    - Uses a higher wavelength of light and so penetrates deeper than SD-OCTs
  - iVue (SD-OCT) has a stable mirror and allows faster image capture and greater resolution, especially for corneal pathology
- Image reliability is key, regardless of brand
  - Pay attention to reliability indices on the scans



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OCT: ANTERIOR SEGMENT TIPS

- Check patient head position
  - When you make adjustments to the scanning beam, the chinrest moves automatically (Visante)
    - If the patient doesn't move along with the chinrest, you may not see the structure you wish to scan
    - If you don't see any change in the scan window despite your adjustments, the reason is usually an issue of head position
  - Some patients will move their head to try to give you a better scan (all machines!)
    - "Stay still, you don't need to move. Let the machine do the work."
- Keep the image horizontal
  - Usually, if the patient is looking straight ahead, the image will look tilted on the screen
  - Adjust the fixation a little bit to the side = make the image more horizontal

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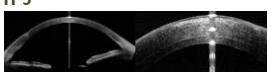
OCT: ANTERIOR SEGMENT TIPS



- Look for the reflex saturation beam
  - Corneal Reflex Artifact
  - When the cross-section of an AS-OCT image is on a corneal meridian, a vertical white beam (central vertical flare) appears in the anterior chamber and a small hyper reflective area appears on the corneal surface on both the Visante and SD-OCT images
  - If the scan beam is perpendicular to the eye, you'll see a bright line in the center of the image
  - An ideal image will be horizontal, with no blink or lid artifacts, and the bright reflex saturation line going through the middle of the scan
  - Corneal pachymetry: create this corneal reflex artifact on the vertex to get an accurate reading

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OCT: ANTERIOR SEGMENT: IMPROVING COMMUNICATION

"Explaining to patients my reasoning for performing peripheral iridectomy for narrow-angle glaucoma is one of the most difficult tasks I face.

When patients present feeling asymptomatic, the last thing they want to or expect to hear is, "I have to put a little opening in your iris with a laser. It's not going to feel very good, you're going to need drops for a few days, and it's not going to improve your vision." They are often less than thrilled.

While diagrams are great, imaging the patient's anterior chamber angle and showing them your concern of potential angle closure is made much simpler by AS-OCT images. Utilizing AS-OCT images bolsters the patient's understanding and acceptance of peripheral iridectomy."

- James S. Lewis, M.D.

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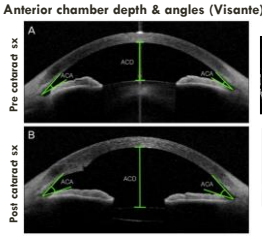
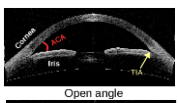
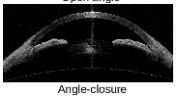
OCT: ANTERIOR SEGMENT PATHOLOGY

Anterior chamber depth & angles (Visante)



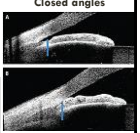


Open angle



Angle-closure

Narrow angles vs. Closed angles



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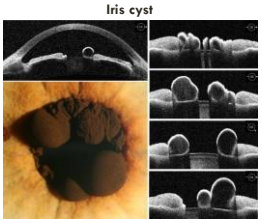
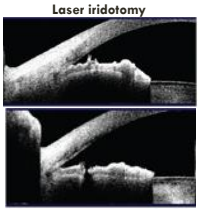
OCT: ANTERIOR SEGMENT PATHOLOGY

Iris cyst



Laser iridotomy



Use OCT to make sure the iridotomy is open

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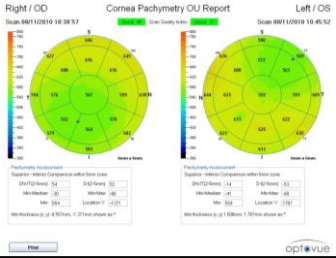
OCT: ANTERIOR SEGMENT



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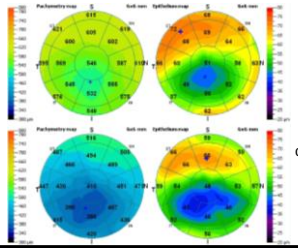
OCT: ANTERIOR SEGMENT PATHOLOGY

Keratoconus progression



NOT a replacement for corneal topography!

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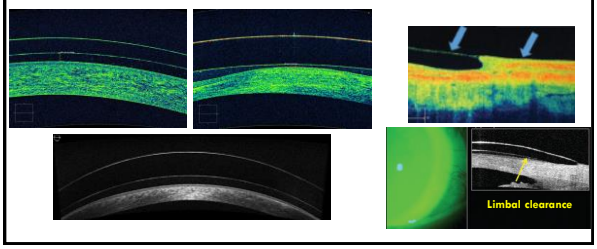
OCT: ANTERIOR SEGMENT: SCLERAL CL FITTING



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FUNDUS PHOTOGRAPHY

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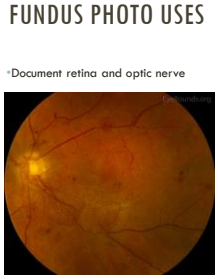
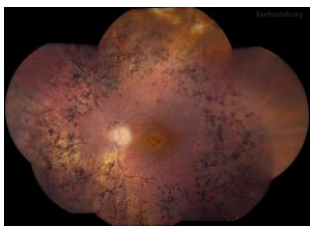
FUNDUS PHOTO USES

- Document retina and optic nerve





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GENERAL TIPS (LIKE OCT!)

- Clean the lens thoroughly between patients.
- **Dilation** will often improve signal strength, image quality and the fundus image.
- To improve patient fixation and reduce distraction, patch the fellow eye, particularly in patients with poor vision.
- Instruct patients to close eyes between each acquisition of photos to keep the corneal surface lubricated.
- Use artificial tears with dry eye patients.
- Use an assistant to help with head fixation and support in cognitively impaired and physically disabled patients.

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GENERAL TIPS (LIKE OCT!)

- Adjust table height for wheelchair patients and perform the photo with the patient in the wheelchair.
- When focusing the camera, the patient should be instructed where to fixate and to "keep teeth together, chin down and head still."
- Patients with nystagmus
  - Try to time the photo to a null point in the nystagmus
  - May have to use techniques like physically turning the patient in a particular direction
- No matter how good you are…. **You can't create clarity where there is none!**
  - Sometimes the image quality isn't good (ex. Dense cataract, poor dilation)
  - With FP, cataract/dilation/cornea really matters– OCT has a better chance to get through to the retina!

https://www.aao.org/eyenet/article/oct-getting-best-images

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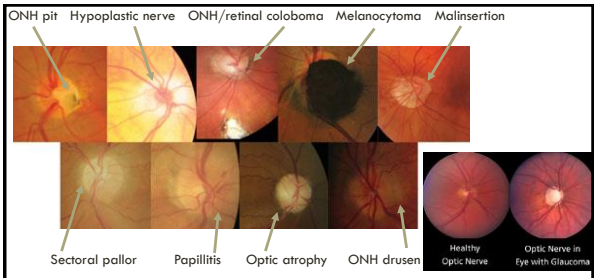

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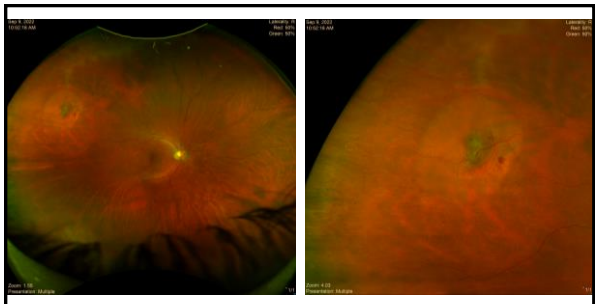

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VISUAL FIELD TESTING

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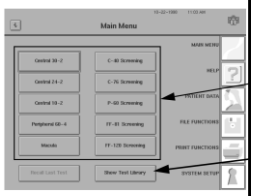
TEST CHOICE

Common threshold patterns are 10-2, 24-2, 30-2

Field analysis in glaucoma relies primarily on the 24-2 and 30-2 patterns
- The majority of ganglion cells lie within the central 30 degrees of fixation

Use of 24-2 has become increasingly prevalent as the test of choice in glaucoma due to its faster testing time and reduced trial lens and lid artifact errors

Macula tests (plaquenil) 10-2
- Also use for advanced glaucoma



https://www.reviewofoptometry.com/article/10-tips-for-improving-visual-fields

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MODIFIED TESTING STRATEGY

Stimulus size III is standard
- Use with patients with 20/200 or better

Increase size to V in patients with poorer vision
- Also applicable in some patients with advanced glaucoma

When altering the stimulus, keep in mind that the normative database, SITA test strategy, and **progression analysis** will no longer be available.

When severe field loss in advanced glaucoma is present, change to a 10-2 pattern to allow for more accurate assessment of the remaining visual field.

In cases where vision is reduced due to macular disease or central scotoma, use a diamond fixation target
- This displays four LEDs, allowing the patient to center their gaze between the targets.

https://www.reviewofoptometry.com/article/10-tips-for-improving-visual-fields

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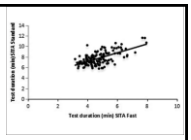
SITA-STANDARD VS. SITA-FAST



Swedish Interactive Thresholding Algorithm (SITA) Standard

24-2 pattern with stimulus size III is generally the preferable test for most routine glaucoma and neurological testing

Clinicians often have the misconception that SITA-Fast strategy is an easier test for patients who have difficulty taking a SITA-Standard or full threshold strategy test

- SITA-Fast does take 2-5 minutes per eye to perform (compared with 3-7 minutes per eye for SITA-Standard)
- However, the algorithm it uses presents points requiring more discretion from the patient
- SITA-Fast is best used in experienced test takers or young patients

https://www.reviewofoptometry.com/article/10-tips-for-improving-visual-fields

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TECHNICIAN RESPONSIBILITY

Take the tests yourself, so you can more effectively explain it to patients

Technicians should always be present during the testing period

- Provide re-education, as necessary
- Provide feedback regarding testing reliability

Explain brightness and size variability

Explain importance of fixation

"The machine will re-test points it thinks you should have seen, so don't worry too much about missing one or two."

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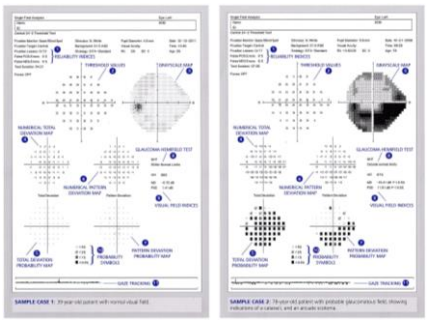

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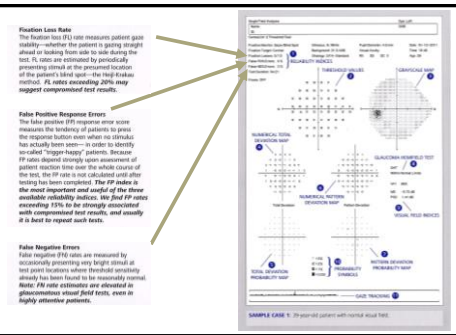

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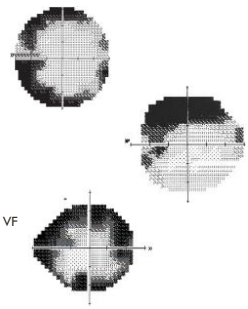
VF ARTIFACTS



Ring artifact: from incorrect trial lens position

- Typically too far from eye

Lid artifact: ptosis, dermatochalasis

- May need to tape lids
- Blepharoplasty candidates

Incorrect corrective lens: general depression in VF

Cloverleaf field: malingering, inattention

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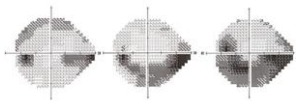
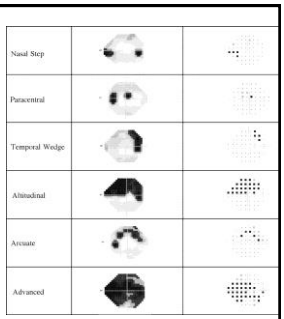
GLAUCOMA VF LOSS





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COMBINED PATHOLOGY

See the whole picture!

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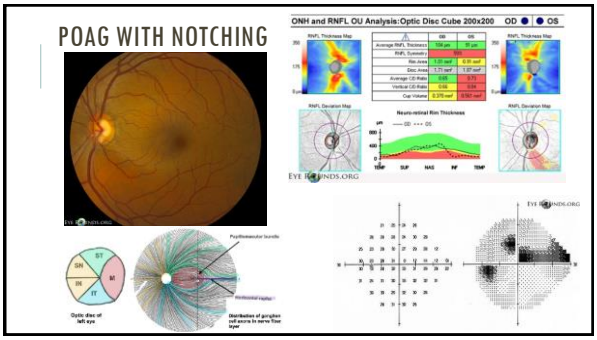
POAG WITH NOTCHING



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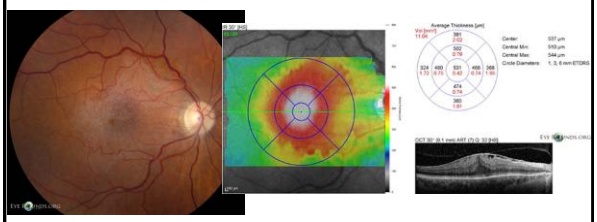
ERM (CELLOPHANE MACULOPATHY/MACULAR PUCKER)



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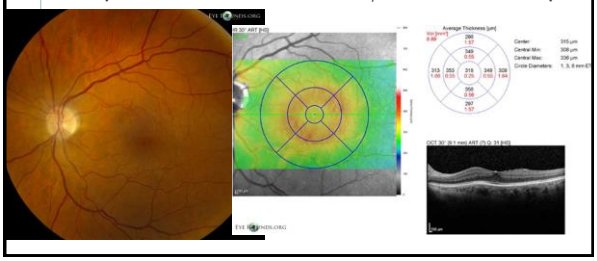
ERM (CELLOPHANE MACULOPATHY/MACULAR PUCKER)



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CONE-ROD DYSTROPHY

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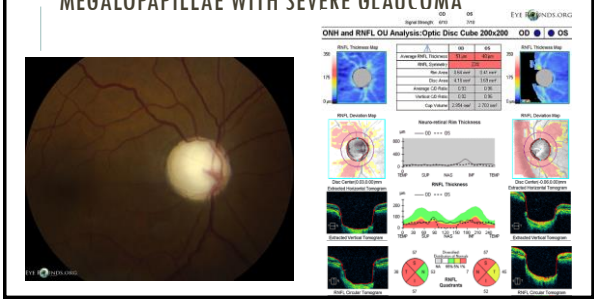
MEGALOPAPILLAE WITH SEVERE GLAUCOMA



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LAMELLAR HOLE

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AMSLER GRID TESTING

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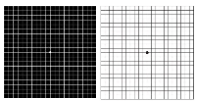
AMSLER GRID



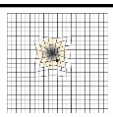
Amsler grid testing examines the central 10 degrees of the visual field

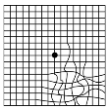
The patient is instructed to look at the black dot in the center of the grid, while wearing near correction

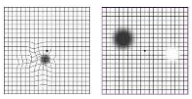
Each eye should be tested individually

Any irregularities in the straight lines around the grid are noted by the patient.

- Waviness of the lines
- Gray or fuzzy lines
- Absent areas of the grid







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VARIATIONS

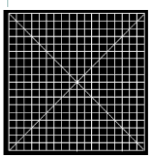

Chart 2: Two diagonal white lines to assist steady fixation in patients with a central scotoma.

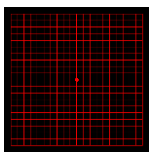

Chart 3: Uses a red grid. Useful in toxic amblyopias and optic neuritis.

Chart 4: Used to distinguish scotoma from metamorphopsia, as there are no forms to be distorted.

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VARIATIONS

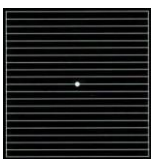

Chart 5: can be rotated to change the orientation of the lines. Used to investigate metamorphopsia along specific meridians.

Chart 6: black lines on a white card with additional lines at 0.5° above and below fixation.

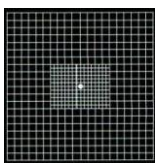

Chart 7: similar to Chart 1 but with additional smaller squares centrally. More sensitive, used for detection of subtle macular disease.

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AMSLER: COMMON ERRORS

Not ensuring that the patient views the central fixation target throughout the test

Using an incorrect working distance

- 16in/40cm

Using an inappropriate near correction

Using the patient's bifocals with a small reading area

Performing the test binocularly

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STEREOPSIS

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STEREOPSIS

- AKA Depth perception
  - Driving, sports, hand-eye motor relationship
- Allows us to gauge spatial relationships
- Binocular disparity
  - Two forward-facing eyes separated by a small distance
  - Gives slightly different vantage points that the brain puts together to see depth
- Need to have images of equal quality

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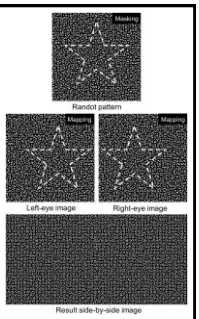
STEREOACUITY

- Measurement of the stereoscopic threshold derived from the minimum disparity that results in the appreciation of depth
- Quantitatively test in seconds of arc
- **Local stereopsis** is detected with stereograms that have individual elements (monocular clues)
- **Global stereopsis** is detected using dot stereograms (complex visual task)



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STEREO: TYPES OF TESTS

- Lang I: Uses random dot and cylindrical gratings, no filters
  - Cat, star, car
  - 1200-550 sec
- Lang II: similar to Lang I
  - Elephant, car, moon
  - 600-200 sec
- TNO: red/green filters for dissociation, identify hidden objects in a series of plates

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STEREO: TYPES OF TESTS

- Titmus: cross-polarized filters, identify the elevated circle or animal
  - Wirt fly @3700 sec
  - 800-100 sec
- Randot: polarized vectographs are used to present different images to each eye
  - Light polarization is undetectable to human eye; use filters
  - 400-20 sec circles, 400-100 sec animals, 500-250 sec global

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STEREO TESTING: RANDOT

- Always test using near vision correction
  - Impaired acuity will blur the patterns even in a normal stereo px
- Check for suppression: R+L box
  - Relative stability can indicate eye dominance
- Hold the test upright, not tilted
- Use adequate lighting but avoid glare
- If the test is upside-down, the images will appear inside the page instead of above it
- Some shifts in in the contours of the Randot circles are visible monocularly– even "one-eyed" patients can see this!

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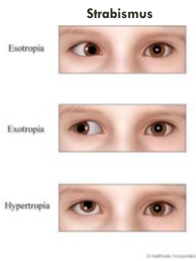
WHAT HAPPENS WITH AMBLYOPIA?

- Developmental disorder that degrades spatial vision and stereopsis
- Unclear image is delivered to the brain from one or both eyes
- Commonly known as "lazy eye"
  - THIS DOES NOT MEAN THAT THE EYE TURNS!!!! That's **strabismus**

Amblyopia (lazy eye): reduced refractive power, deprivation, or strabismus causes a lack of visual stimulation that results in insufficient information being transmitted through the optic nerve to the brain. The affected eye will not develop properly.

Strabismus (crossed eyes): When a patient is unable to align both eyes. This lack of coordination prevents both eyes being able to focus on the same point in space.



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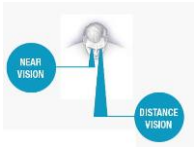
WHAT ELSE CAN DEGRADE NORMAL STEREOACUITY?

- Monocular patient
  - Injury, insult, etc.
- Monovision
  - Cataract sx
  - LASIK sx
  - Contact lenses
  - "Natural" monovision
- **Anything that reduces the image quality of one eye relative to the other!**



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COLOR VISION

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COLOR VISION: USES

Hereditary deficiencies
- Abnormality or absence of one of more of the 3 cone types (R, G, B)
- Red and green are most commonly affected

Acquired deficiencies (afferent visual pathways)
- Due to disease/trauma or drug toxicity
- Typically blue-yellow defects

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TESTING METHODS

Identify numbers, letters, or shapes
- Ishihara: most commonly used, tests red-green
- HRR (Hardy-Rand-Ritter): tests blue-yellow

Arrange colored targets in spectral sequence
- D-15 panel
- Farnsworth-Munsell




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ISHIHARA

VA must be 20/200 or better

Don't let px touch the plates- oil from hands can degrade the colors!
- Use a clean, dry paintbrush to trace patterns

Tech holds the plates
- Perpendicular to the line of sight for a maximum of 3 seconds

Tech turns the plates, not the patient

Monocular test (especially important for optic nerve disease)

First plate is a test plate: EVERYONE should see the "12"

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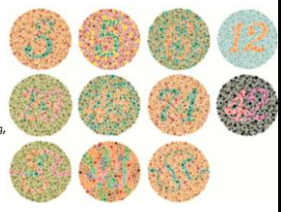
ISHIHARA

#2-7 Transformation: Normal reads one number, deficient reads another

#8-13 Vanishing design: Normal reads a number, deficient reads nothing

#14-15 Hidden digit design: Normal reads nothing, deficient may read "5" or "45"

#16-17 Diagnostic plates
- "red (protan) defective reads right side"



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EXTRA PATHOLOGY SLIDES

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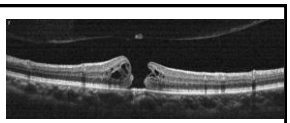
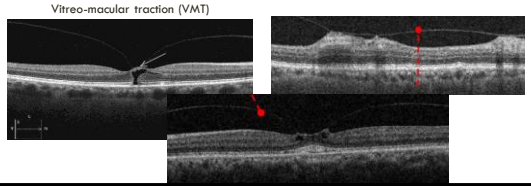
MACULA PATHOLOGY



Vitreo-macular traction (VMT)



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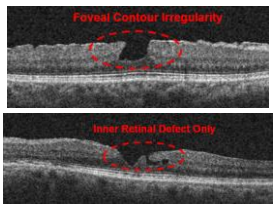
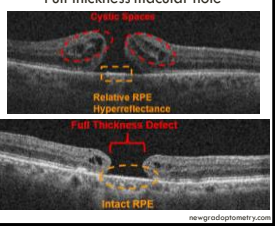
MACULA PATHOLOGY

Pseudohole vs. lamellar hole



Full thickness macular hole



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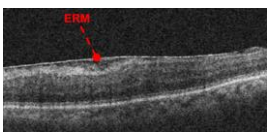
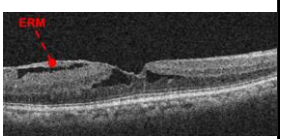
MACULA PATHOLOGY





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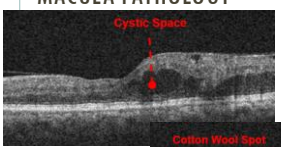
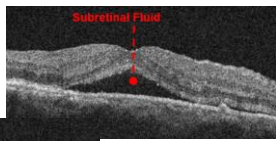
MACULA PATHOLOGY





If CWSs are outside the Macular Cube Scan, Zeiss Cirrus allows for the easy change of retinal scan location by dragging the "scan box" to the zone of interest

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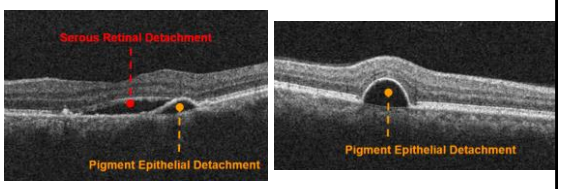
MACULA PATHOLOGY



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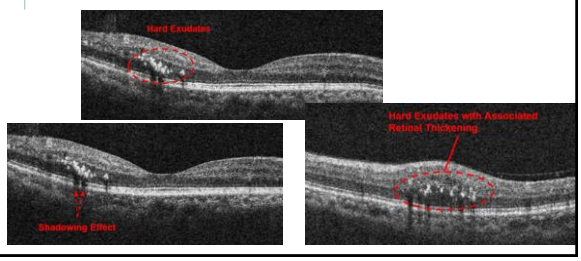
MACULA PATHOLOGY



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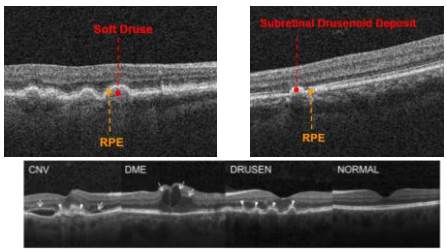
MACULA PATHOLOGY



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THANK YOU!

dr.barrettzeitlin@gmail.com

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