INTERPRETING RETINAL OCT'S & INTRODUCING OCT-ANGIOGRAPHY

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- Disclosures
  - Aerie Pharmaceuticals
  - Alcon
  - BioTissue
  - Diopsys
  - Ivantis
  - MacuLogix
  - Nidek
  - Nova Oculus
  - Optovue
  - Quantel
  - Reichert
  - RevolutionEHR
  - Shire
  - Sight Sciences
  - Sun Pharma

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PollEverywhere

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- Type in:
  - pollev.com/natelighthizer
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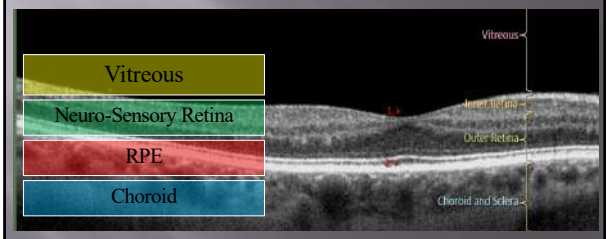
4 Basic Categories: Diseases of the….



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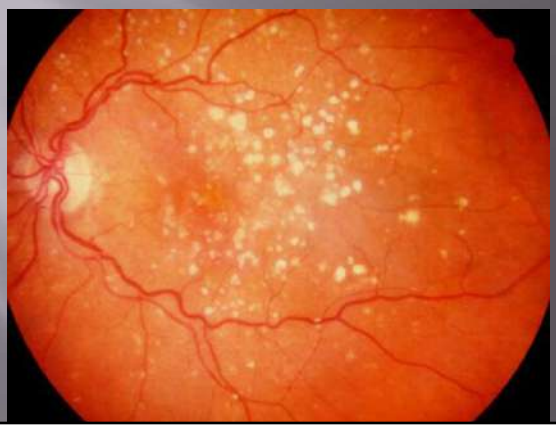

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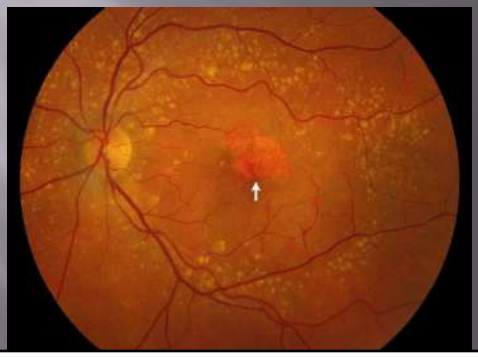

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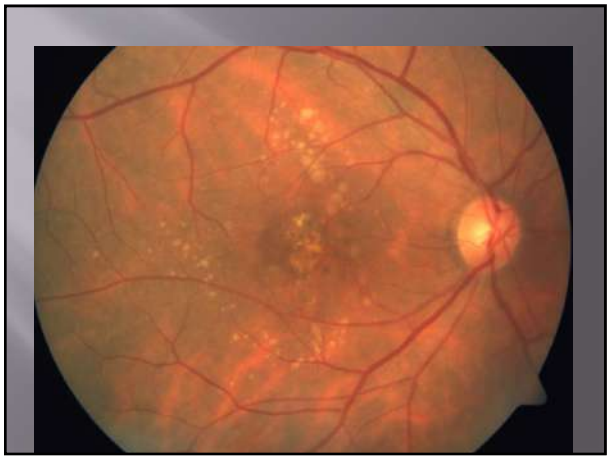

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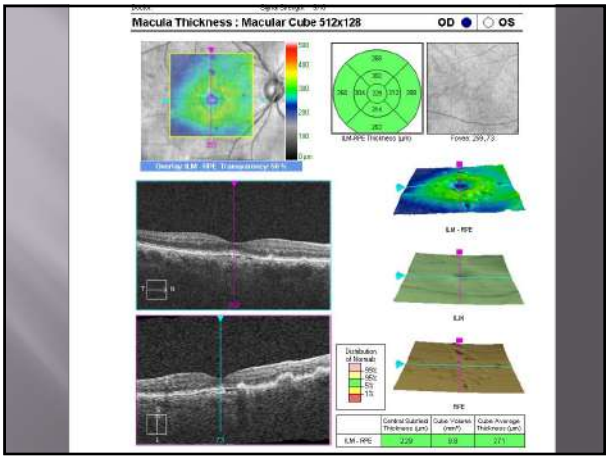
Macula Thickness : Macular Cube 512x128
OD
OS

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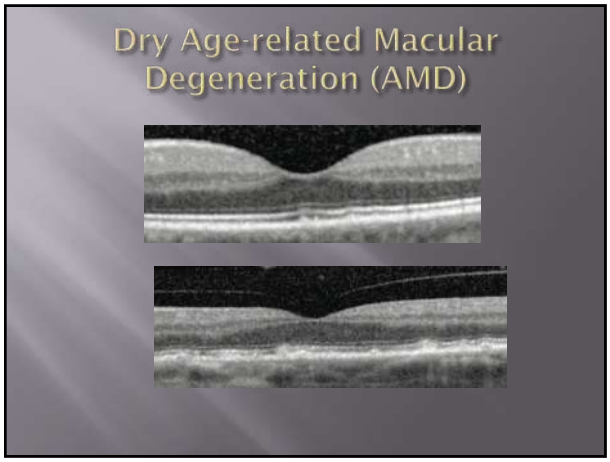
Dry Age-related Macular Degeneration (AMD)

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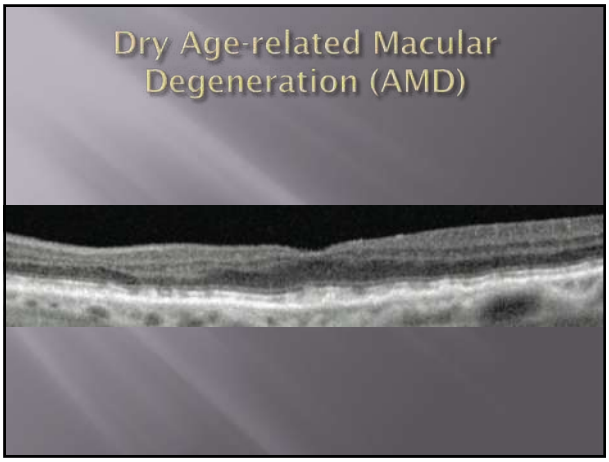
Dry Age-related Macular Degeneration (AMD)

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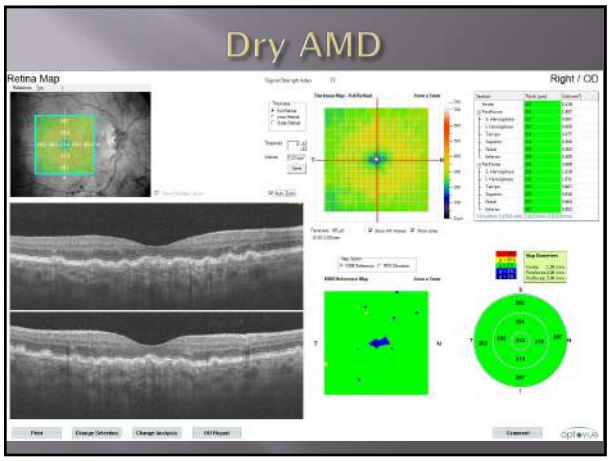
Dry AMD
Retina Map
Right / OD

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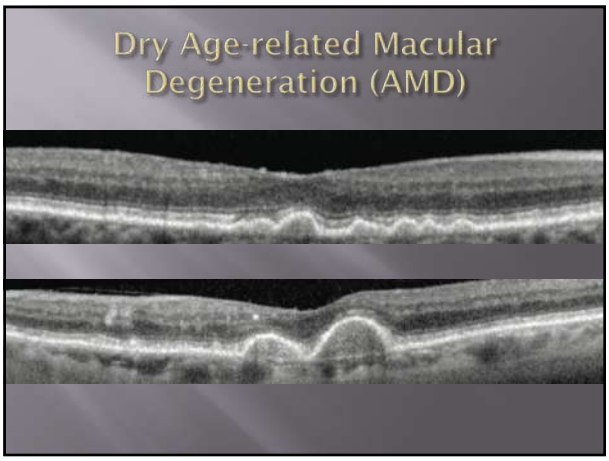
Dry Age-related Macular Degeneration (AMD)

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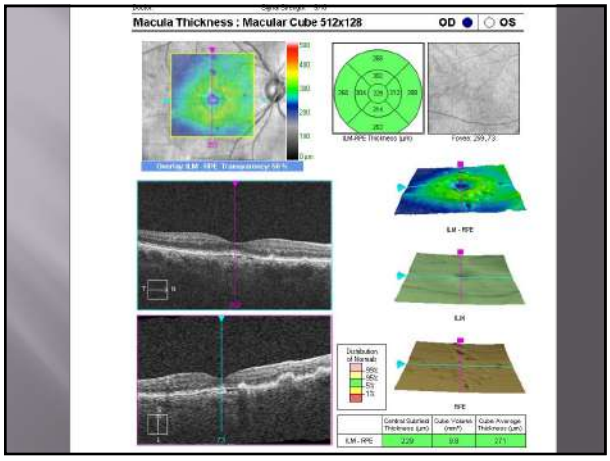

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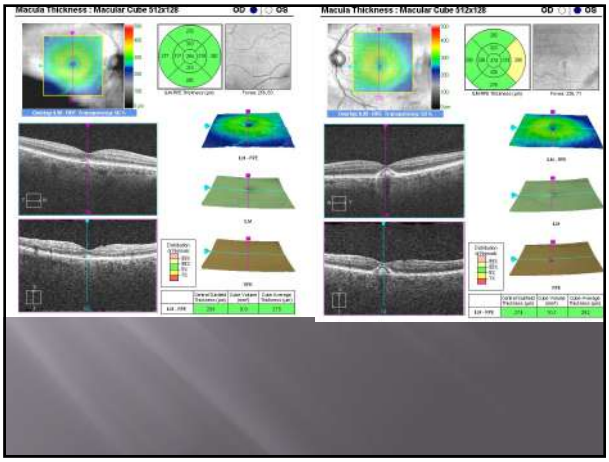

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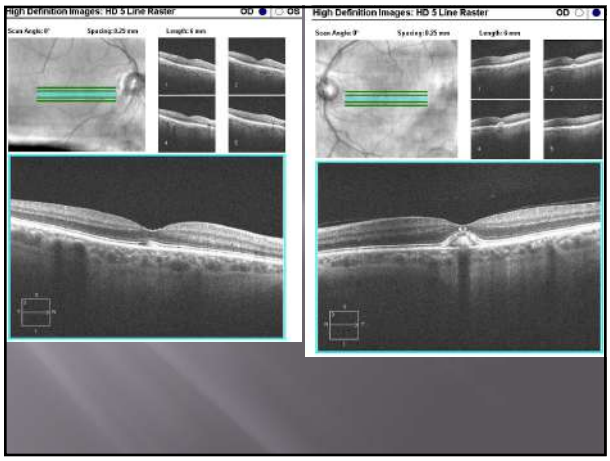

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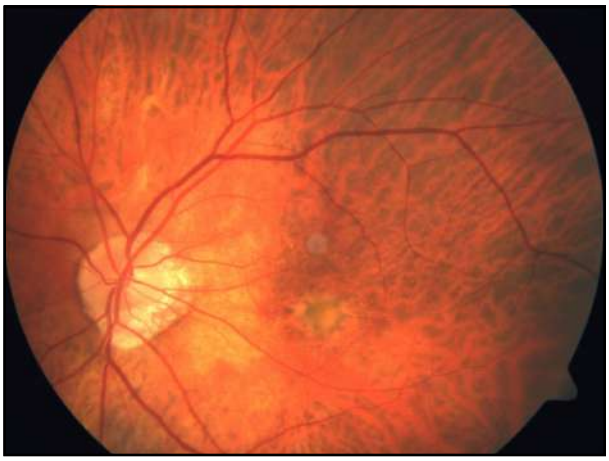

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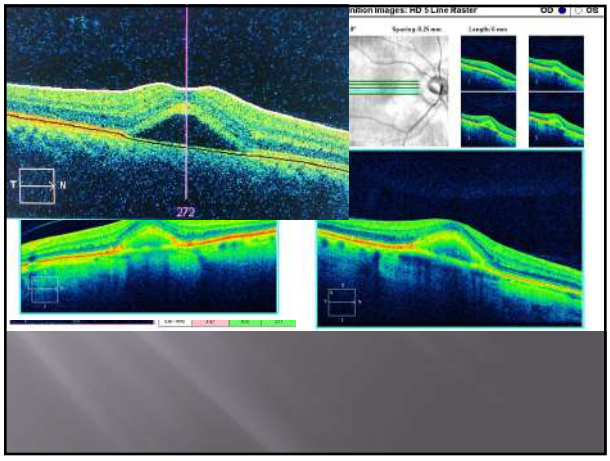

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The left eye shows a normal appearing optic nerve. Here we have an area of central hyperpigmentation with a surrounding halo of hypopigmentation that looks like regressed drusen. The vessels are unremarkable and the retinal periphery is unremarkable.

IMPRESSION:

1. Mild adult vitelliform disease, possibly a small pattern dystrophy, possibly a very early onset of age-related macular degeneration. At the current level no treatment is needed besides routine observation and monitoring.

I have discussed with him that he should check the left and right eyes separately at least, if possible, three to four times a week for a few seconds and see us or you with any new or sudden changes. Beyond this, we have given him information about vitamin supplementation and have not set him up for an immediate follow up with us here, but of course we would be happy to visit back with him if new or sudden changes were to arise.

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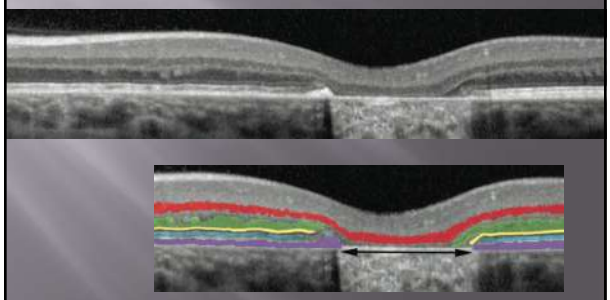
Dry Age-related Macular Degeneration (AMD)



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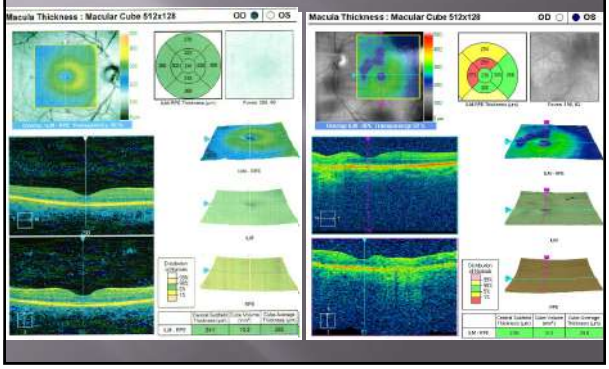
Retinal Atrophy



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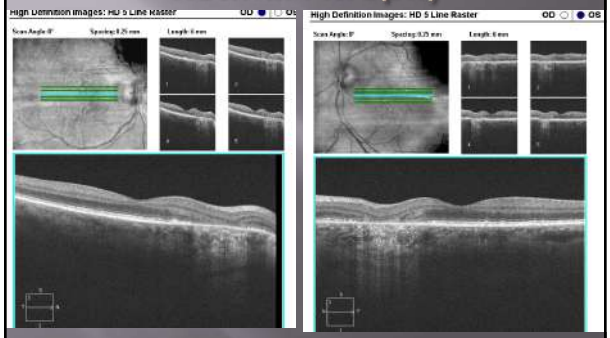
Retinal Atrophy



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Case #6

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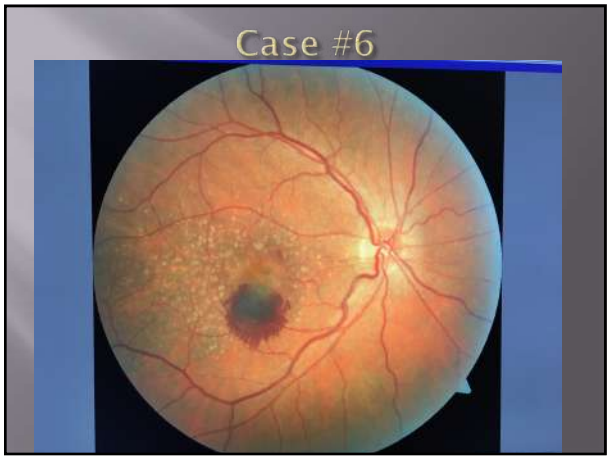

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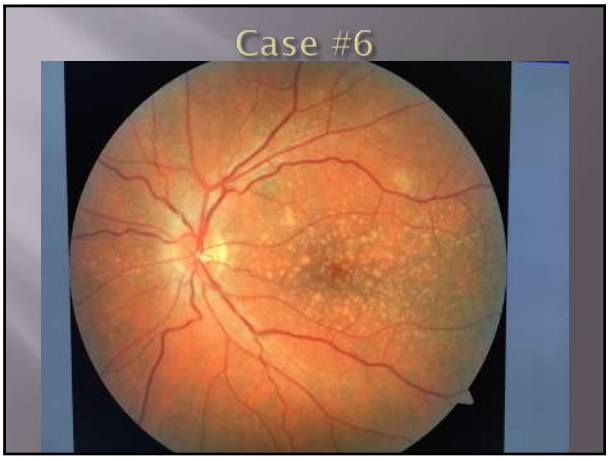

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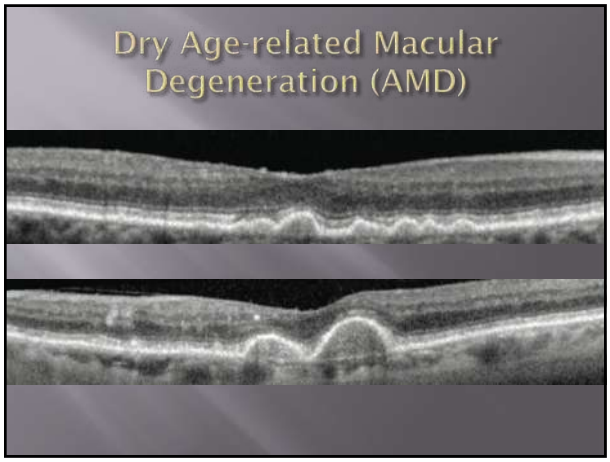

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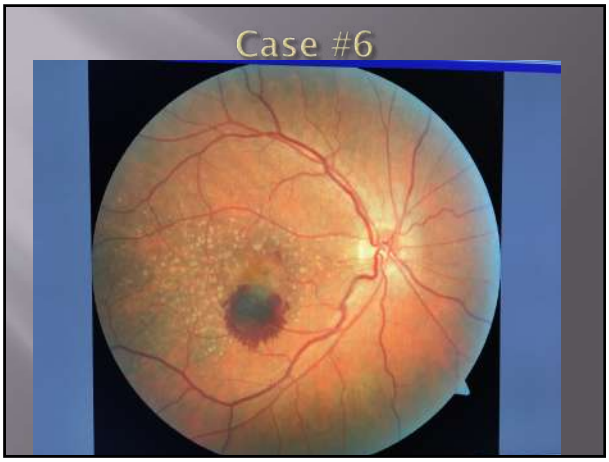

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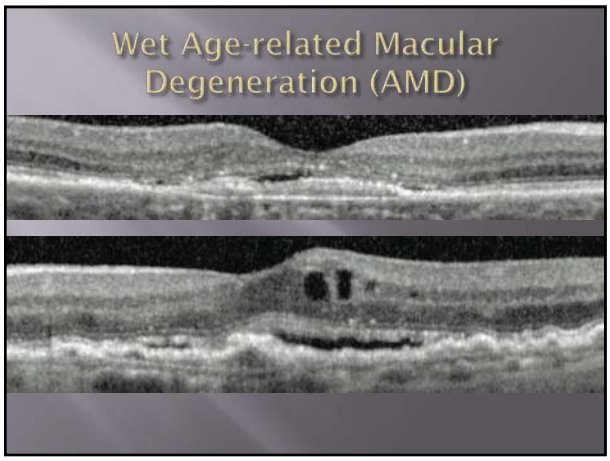

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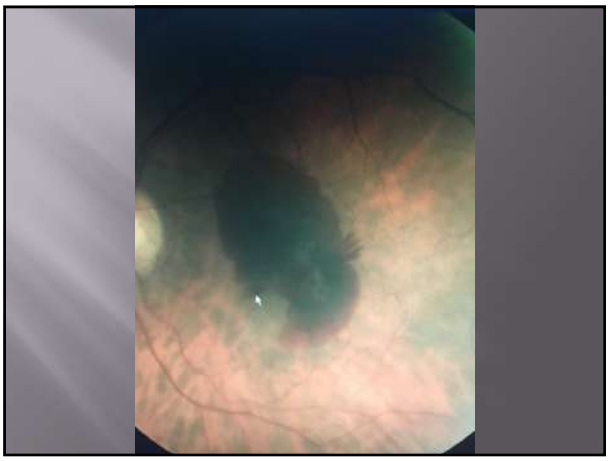

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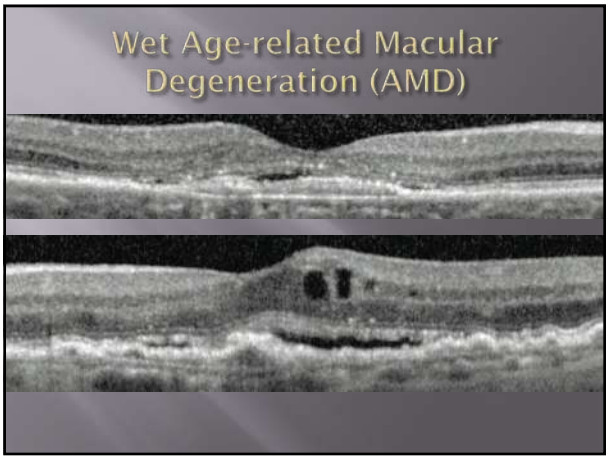

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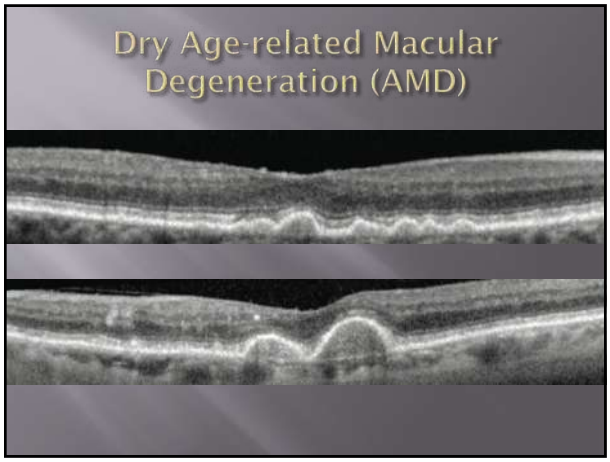

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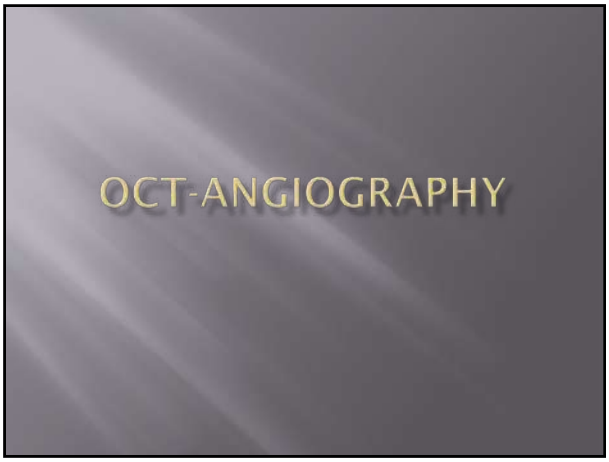

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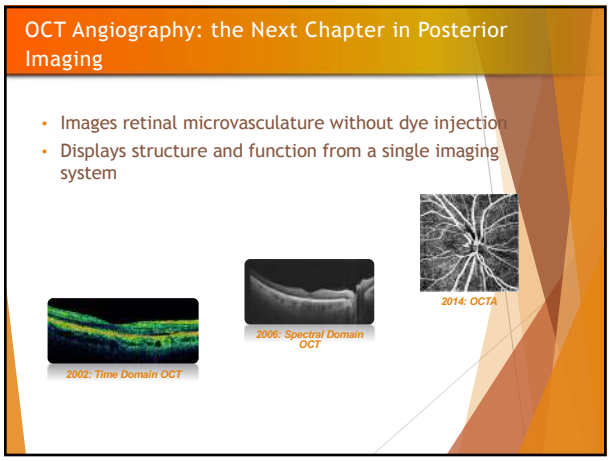

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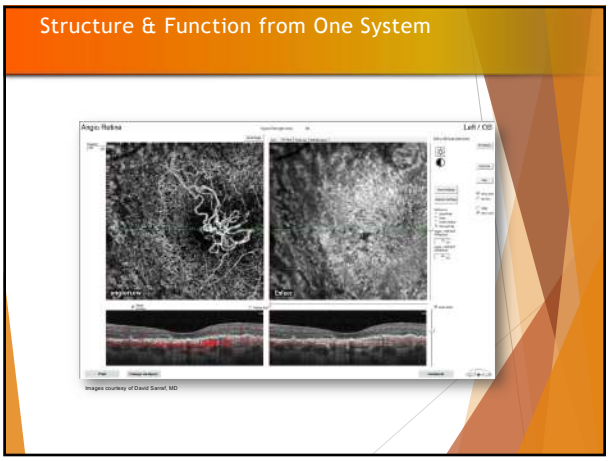

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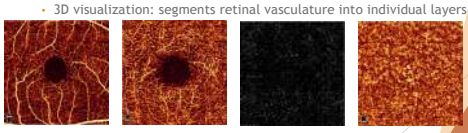
A New Approach to Visualizing Blood Flow

- Patient Benefits
  - Reduces patient burden to allow more frequent imaging
  - Avoid potential side-effects of fluorescein injection
- Clinical Benefits
  - Faster than a dye-based procedure
  - Ultra-high resolution imaging of retinal microvasculature
  - 3D visualization: segments retinal vasculature into individual layers



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OCT-Angiography

How Does it Work?

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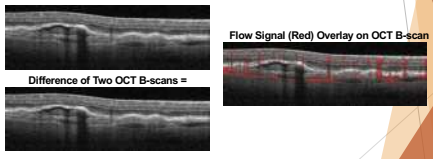
Principles of OCTA

OCTA uses motion contrast to detect flow from OCT data

- Rapidly acquires multiple cross-sectional images from a single location on the retina
- Flow is the difference in signal between two sequential B-scans



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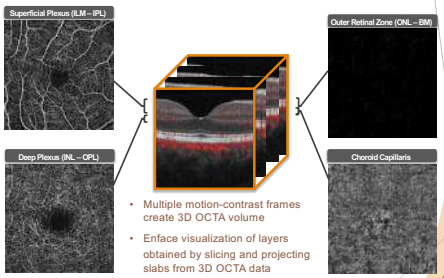
Enface OCTA Generated from OCTA Volume Data



- Multiple motion-contrast frames create 3D OCTA volume
- Enface visualization of layers obtained by slicing and projecting slabs from 3D OCTA data

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OCT-ANGIOGRAPHY

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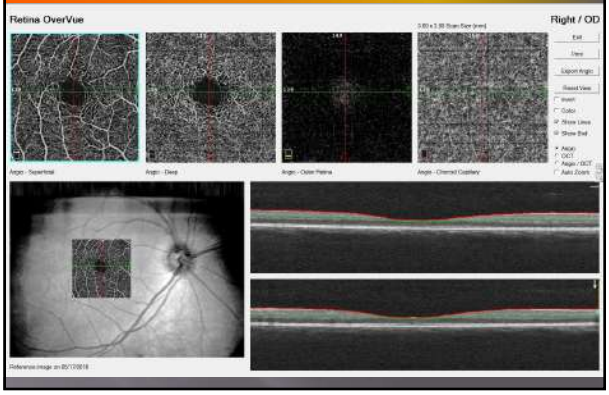
What is normal?



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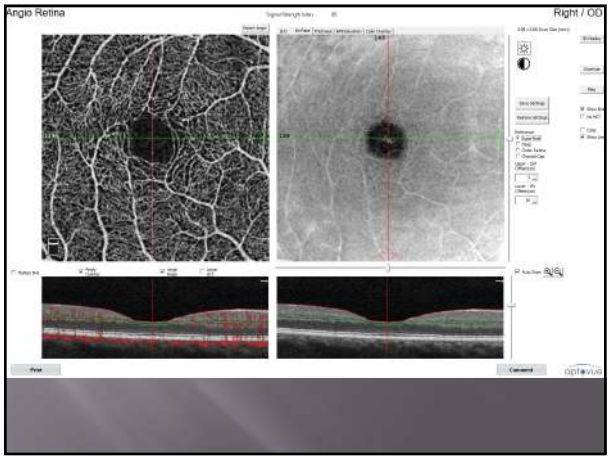

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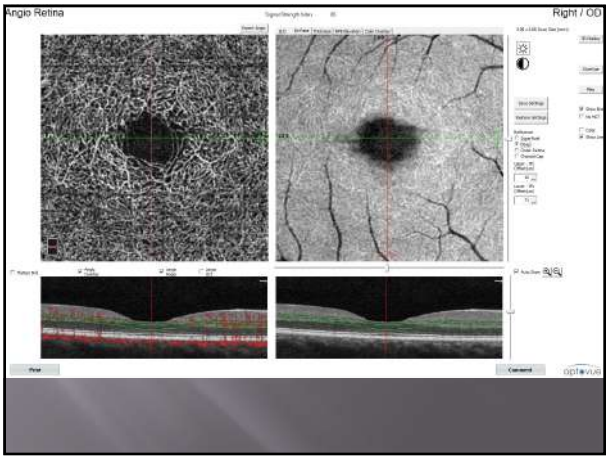

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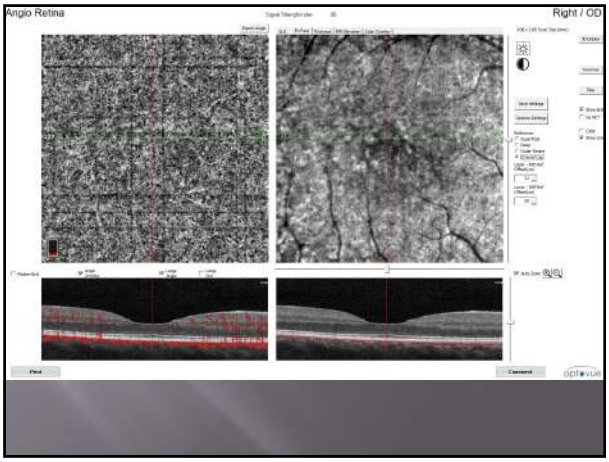

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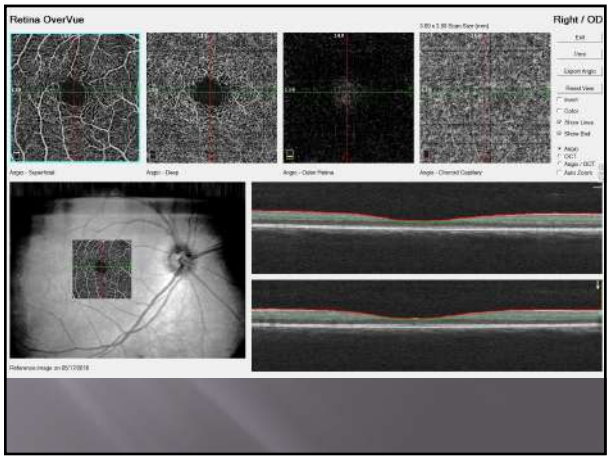

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OCT-A in our clinic

Indications:

AMD – dry vs. wet
Diabetics -
is there neo?
is their non-perfusion (capillary dropout)?
Vein Occlusions
Glaucoma patients
nerve perfusion?

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Case #3 – Wet AMD

8/23/16

71 yoNAf

Referral was for an macular OCT to help differentiate/rule in/out CNVM vs. macular edema vs. central serous choroidopathy

Distance VA's:
OD – 20/20-1
OS – 20/70-1

49

Should I refer or should I watch this?

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DM & the Eye

- Why is this important?
  - DM is the leading cause of visual impairment in working-age adults
  - 25.6 million Americans over age 20 have DM (11%)
    - 1/3 are not aware they have the disease
    - An additional 79 million have impaired fasting glucose levels
  - Retinopathy prevalence rate for individuals over age 40 is 30%
  - Multiple risk factors for retinopathy including duration of DM

"Screening for Diabetic Retinopathy – 2014", American Academy of Ophthalmology, Oct 2014
"Vision Problems in the U.S.", Prevent Blindness America, 2012

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DM & the Eye

- Type 2 DM rate of retinopathy:
  - at 5 years
    - 40% for insulin patients
    - 24% for non-insulin patients
  - At 19 years
    - 84% for insulin patients
    - 53% for non-insulin patients

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DM & the Eye

- Rate of DR progression:
  - No retinopathy
    - Within 1 year 5-10% will have retinopathy
  - Mild NPDR
    - 16% of type I DM will progress to PDR in 4 years
  - Severe NPDR
    - Within 1 year 50% will have PDR
      - 15% will have high risk PDR

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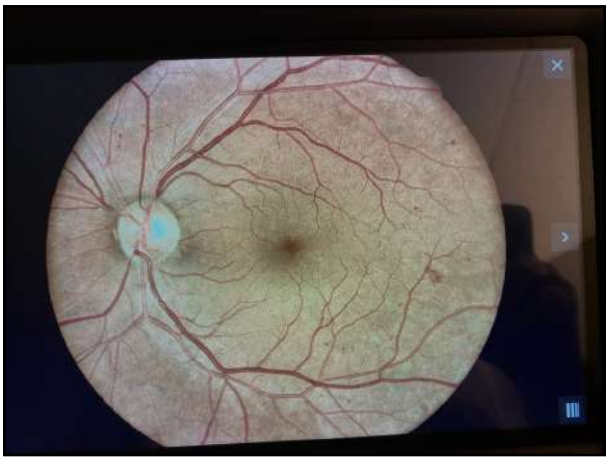

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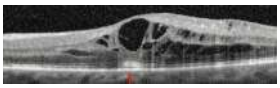
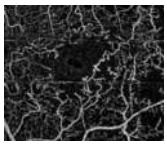
DM & The Macula

- The Macula Can Go Both Ways:
  - Diabetic Macular Edema
  - Diabetic Macular Ischemia
    - Predicts diabetic retinopathy progression
    - 41% of patients with diabetic retinopathy had some degree of macular ischemia
    - Can be tied to VA loss
      - Moderate-severe macular ischemia -> reduced VA
      - Mild macular ischemia -> normal VA





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DM Managed with OCTA

- What are the Advantages?
  - Identify early stages of diabetic retinopathy before other technologies can
  - Less invasive
  - Quick acquisition time
  - Looks at multiple vascular layers within the retina
    - FA can only look at the superficial plexi
    - OCTA has the ability to look at the DCP
  - It localizes MA's to their exact retinal depth
  - Because it is not dependent on contrast injection, it helps to provide detailed information regarding capillaries without fluorescein leakage
- What are the Disadvantages?

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OCTA Indications – Diabetes & Diabetic Retinopathy

- Detect vascular abnormalities prior to funduscopically evident DR (subclinical retinopathy)
  - Macular ischemia/enlargement of the FAZ
  - Qualitative and quantitative data for capillary nonperfusion (capillary dropout)
  - Differentiating IRMA from early neo

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Abnormalities of the foveal avascular zone in diabetic retinopathy.

ENLARGEMENT OF FOVEAL AVASCULAR ZONE IN DIABETIC EYES EVALUATED BY EN FACE OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY.

Enlargement of the foveal avascular zone detected by optical coherence tomography angiography in diabetic children without diabetic retinopathy.

Author information

Abstract

PURPOSE: Evaluation of foveal avascular zone (FAZ) in children with diabetes (DM) using OCTA.

METHODS: We examined 112 diabetic children without DR aged 6-18 years and 30 age-matched controls using OCT Angiography and measured FAZ in superficial (SCP) and deep capillary plexus (DCP). The study group was divided into three subgroups depending on DM duration group 1: < 5 years (n = 40), group 2: 5-10 years (n = 42), group 3: > 10 years (n = 30).

RESULTS: The mean DCP FAZ increased with DM duration from 502.2 μm^2 (SD 137.8) in group 1 to 523.9 μm^2 (SD 159.2) in group 2 and 539.7 μm^2 (SD 189.1) in group 3. Control group differed significantly from group 1 ($p = 0.0120$), group 2 ($p = 0.0019$) and group 3 ($p = 0.0011$). The mean DCP to SCP FAZ surface ratio was 1.88 (SD 0.68) in the study vs 1.58 (SD 0.48) in the control group ($p = 0.0232$). The DCP and SCP FAZ surface difference was 217.6 μm^2 (SD 100.8 μm^2) in diabetics vs. 124.2 μm^2 (SD 72.8 μm^2) in controls ($p < 0.0001$). In the control group, it was significantly smaller than in group 1 ($p < 0.006$), group 2 ($p < 0.0001$) and group 3 ($p < 0.0001$).

CONCLUSIONS: Changes can be detected in FAZ of diabetic children before DR development which can be vital for screening.

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OCTA Indications – Diabetes & Diabetic Retinopathy

- Detect vascular abnormalities prior to funduscopically evident DR (subclinical retinopathy)
  - Macular ischemia/enlargement of the FAZ
  - Qualitative and quantitative data for capillary nonperfusion (capillary dropout)
  - Differentiating IRMA from early neo

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Assessment of capillary dropout in the superficial retinal capillary plexus by optical coherence tomography angiography in the early stage of diabetic retinopathy.

Author information

Abstract

BACKGROUND: To assess capillary dropout in the superficial retinal capillary plexus (SCP) by optical coherence tomography angiography (OCTA) in the early stage of diabetic retinopathy (DR).

METHODS: This study was a cross-sectional observational study. Patients that underwent OCTA examinations in our hospital between November 2015 and May 2016 were included in the study. The subjects were divided into two groups: A) normal controls (41 eyes of 41 subjects) and B) the DR patients (49 eyes of 49 patients with mild non-proliferative DR (NPDR)). The retinal thickness and SCP vessel density were analyzed using built-in software in nine sections of the macular area: whole scan area; fovea; parafovea; and sub-sections of the parafovea: superior-hemi, inferior-hemi, temporal, superior, nasal, and inferior. The correlation between vessel density and retinal thickness was also analyzed.

RESULTS: The SCP density was significantly lower ($P < 0.05$) in mild NPDR patients than in normal controls in all areas, with the exception of the fovea ($P > 0.05$). In the parafovea, superior-hemi, inferior-hemi, temporal, and nasal sectors of group B, the SCP density was negatively correlated with the corresponding retinal thickness ($P < 0.05$). Specifically, as the SCP density decreased, retinal thickness increased.

CONCLUSIONS: In the early stage of NPDR, retinal capillary dropout and retinal thickness changes can be clearly captured and analyzed by OCTA. The results confirm a negative correlation between vessel density and retinal thickness in diabetic patients. This noninvasive technique could be applied for DR detection and monitoring. Further study with a larger sample size is warranted.

KEYWORDS: Capillary dropout; Diabetes mellitus; Diabetic retinopathy; Optical coherence tomography angiography; Retinal capillary

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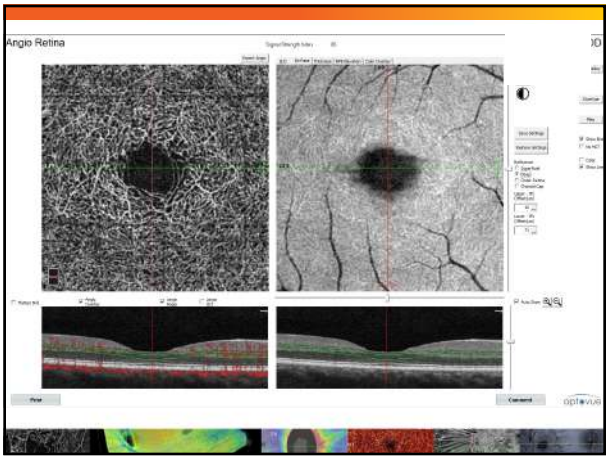

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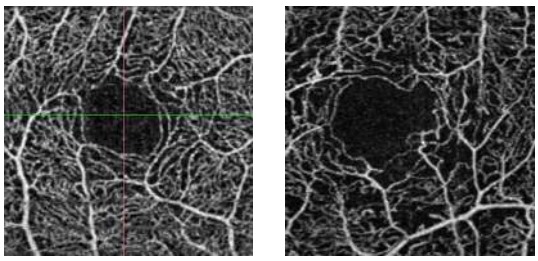
Superficial Plexus



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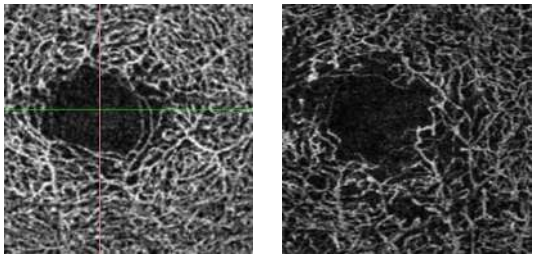
Deep Plexus



64

FAZ Measurements in Diabetic Retinopathy

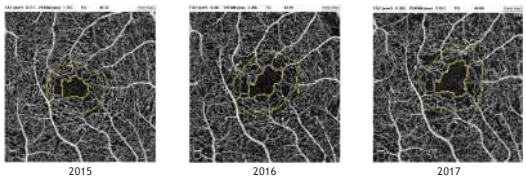
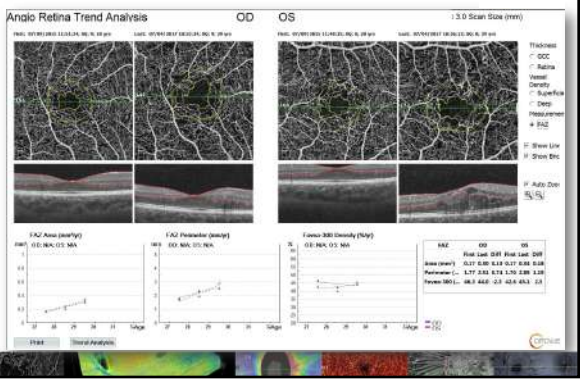


Image courtesy of Bernard C. Saith, OD, Rutgers New Jersey Medical School Department of Ophthalmology and Visual Science

65

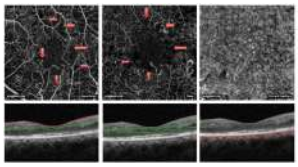
OU Trend Report - FAZ



66

Diabetic Retinopathy

- Positive Indicators
  - Retinal capillary non-perfusion – seen as blackened area without blood flow outside FAZ
  - Microaneurysms
  - Enlarged FAZ

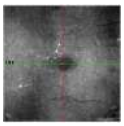


67

Case Study | Diabetic Patient

- 45-year-old African American female
- HbA1C – 7.0 with "Good blood sugar control"

Fundus Image

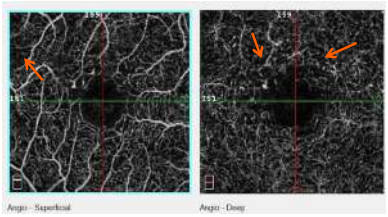


En Face OCT

Looks pretty good…right??

68

But what does OCTA reveal?

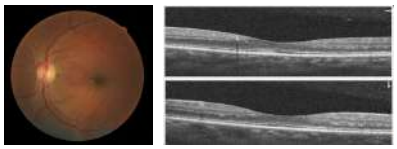


Images courtesy of Julia Rodman, MD

69

Case Study #2 | Diabetic Patient

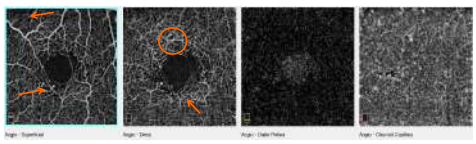
- Blood sugar never higher than 140



Some exudates…no CSME...

70

But what does OCTA reveal?



Images courtesy of Julia Rodman, MD

71

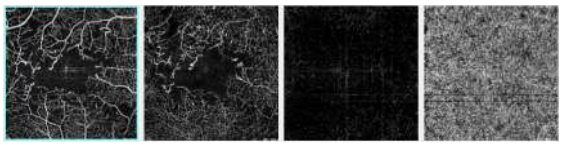
OCTA Indications – Diabetes & Diabetic Retinopathy

- Detect vascular abnormalities prior to funduscopically evident DR (subclinical retinopathy)
  - Macular ischemia/enlargement of the FAZ
  - Qualitative and quantitative data for capillary nonperfusion
  - Differentiating IRMA from early neo

72

Enface OCTA Overview of Pathologies – Diabetic Retinopathy

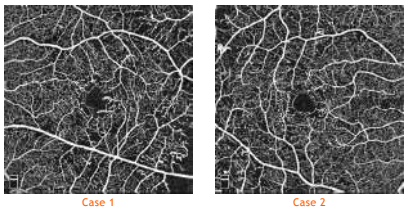
Superficial | Deep | Outer Retina | Choriocapillaris



73

OCT-A Enables Visualization of Microvascular Changes

- Non-Proliferative Diabetic Retinopathy



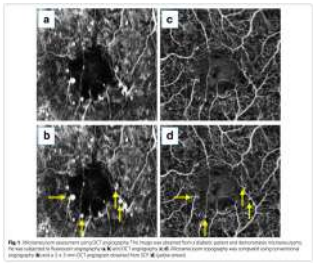
Case 1 Case 2

74

DM Managed with OCTA

- What are the Advantages?
  - Identify early stages of diabetic retinopathy before other technologies can
  - Less invasive
  - Quick acquisition time
  - Looks at multiple vascular layers within the retina
    - FA can only look at the superficial plexi
    - OCTA has the ability to look at the DCP
  - It localizes MA's to their exact retinal depth
  - Because it is not dependent on contrast injection, it helps to provide detailed information regarding capillaries without fluorescein leakage
- What are the Disadvantages?
  - Requires longer fixation than FA
  - Smaller field of view/harder to image peripheral non-perfusion
  - The number of identified MA's was less than FA in studies

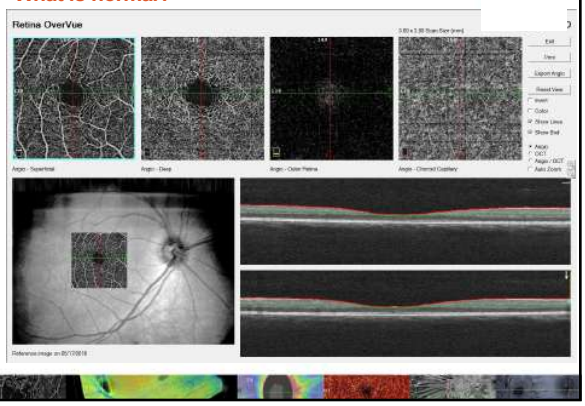
75



de Barros Garcia *et al. Int J Retin Vitr (2017) 3:14*

76

What is normal?



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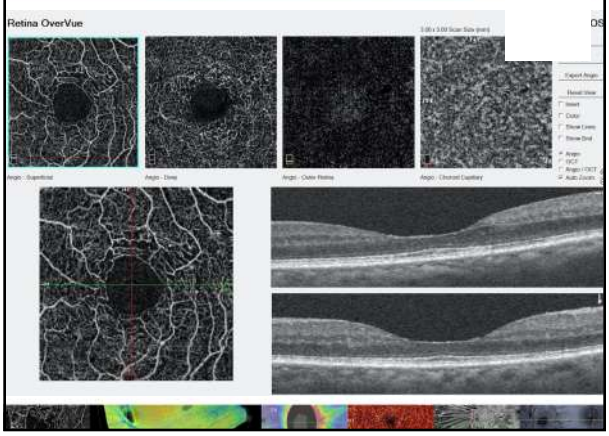

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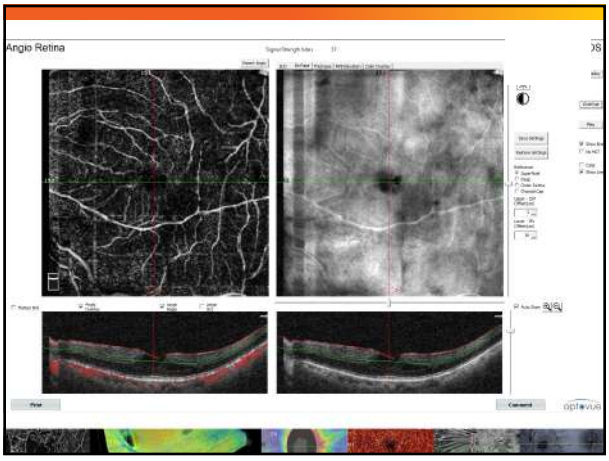
79



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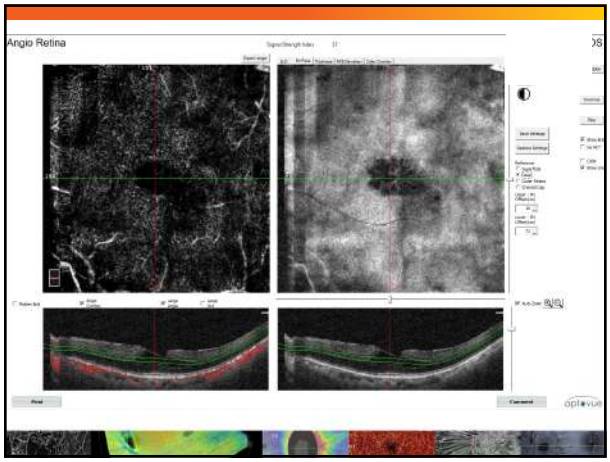

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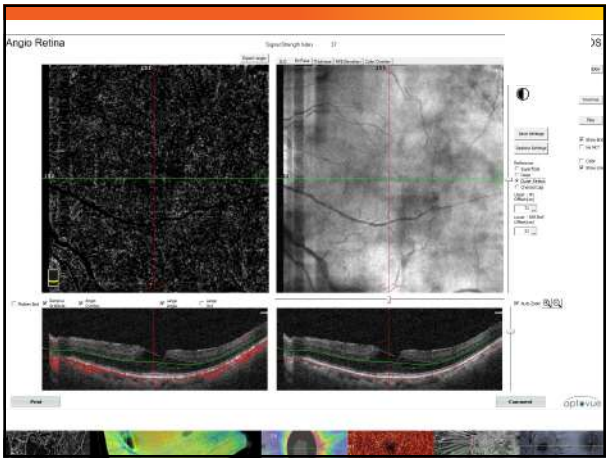

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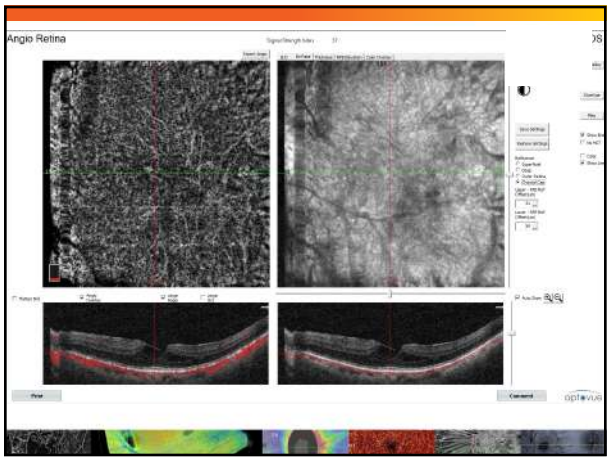

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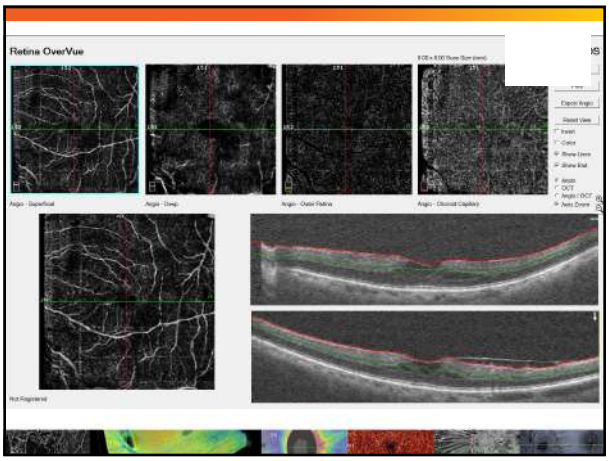

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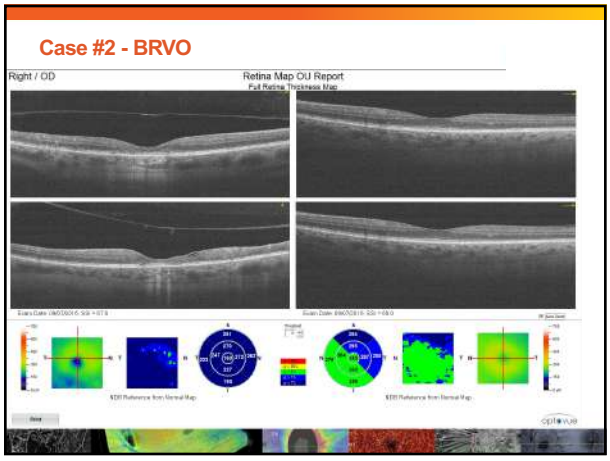

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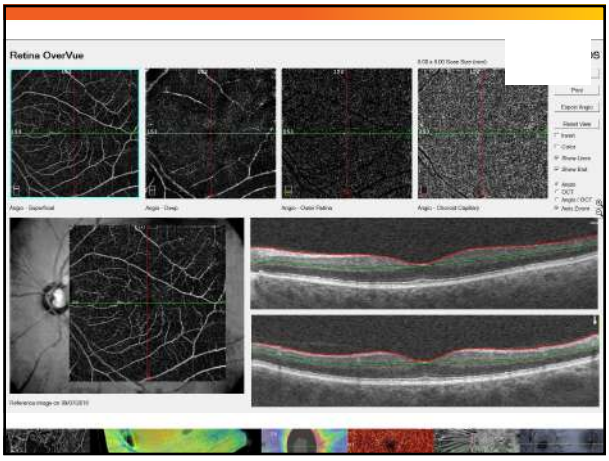

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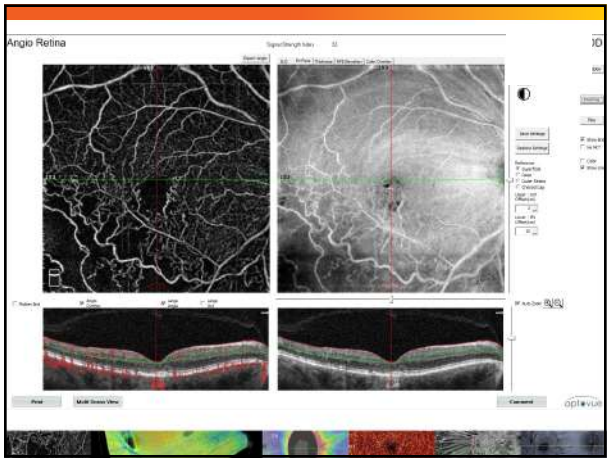

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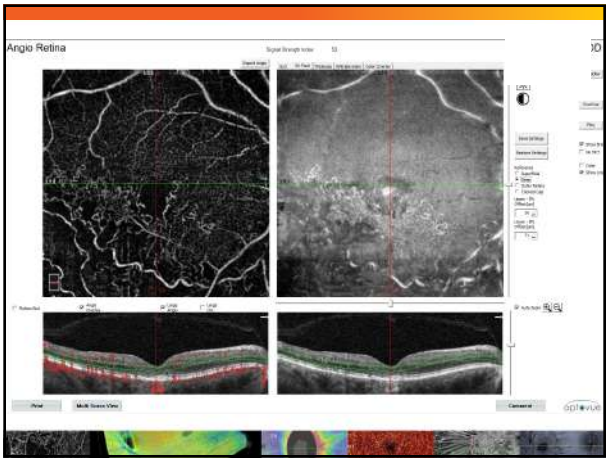

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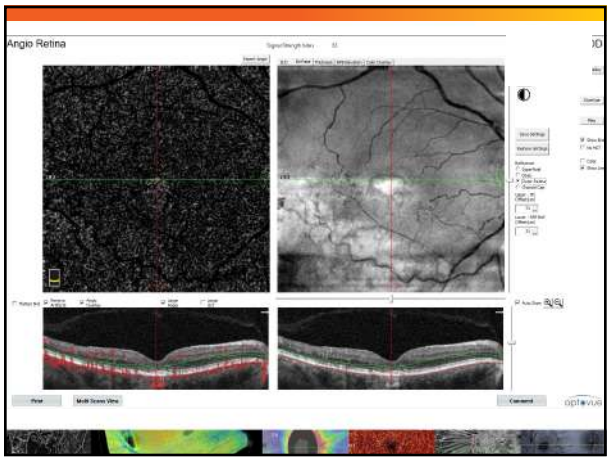

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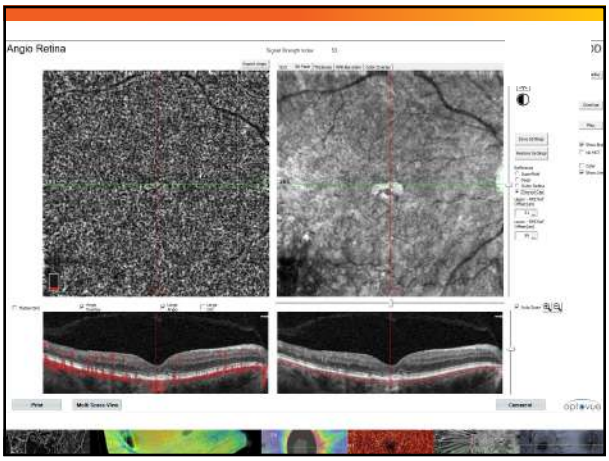

90

DM Managed with OCTA

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  - Quick acquisition time
  - Looks at multiple vascular layers within the retina
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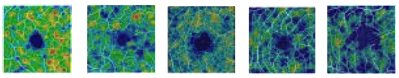
  - It localizes MA's to their exact retinal depth
  - Because it is not dependent on contrast injection, it helps to provide detailed information regarding capillaries without fluorescein leakage
- What are the Disadvantages?

91

Vessel Density Maps Enable Grading of Vascular Change



Images courtesy of Richard Rosen, MD

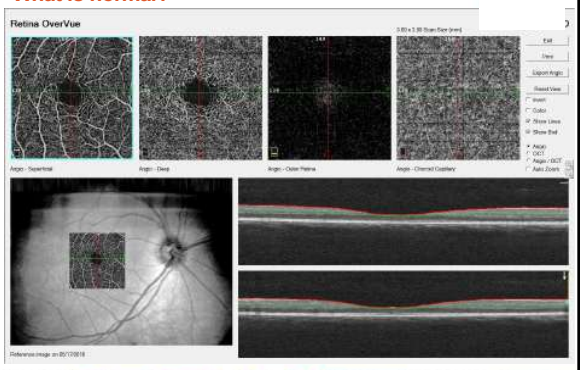
92

AngioAnalytics™

The World's First OCTA Metrics

93

What is normal?



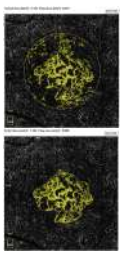
94

AngioAnalytics™

The World's First OCTA Metrics

95

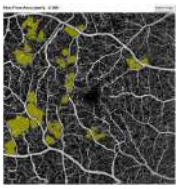
Flow Area Measurements



- Based on outer retina slab or choriocapillaris slab
- Available for 3x3mm and 6x6mm HD scans
- Option to measure within a circular boundary or contoured boundary
- Measurements
  - Select Area: Total area within the circle or contoured boundary
  - Flow Area: Percent of total area occupied by vessels within the circle or contoured boundary
- Clinical Applications
  - CNV

96

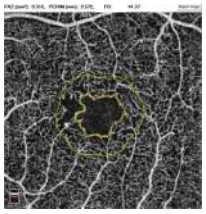
Non-Flow Area Measurement



- Based on superficial vascular complex
- Available for 3x3mm and 6x6mm HD scans
- Measures total area of selected non-flow regions
- Clinical Applications
  - Diabetic retinopathy
  - Vein and artery occlusion

97

FAZ Measurements

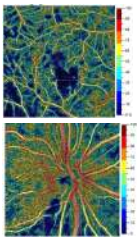


- Based on full retinal vasculature (superficial and deep vascular complexes)
- Available for 3x3mm and 6x6mm HD scans
- Highly repeatable including in diseased eyes[1]
- Measurements
  - FAZ: Area of foveal avascular zone
  - PERIM: Foveal avascular zone perimeter in mm
  - FD: Vessel density (%) within a 300µm width perimeter surrounding the FAZ
- Clinical Applications
  - Diabetic retinopathy

1. Emami-Naeini P, Chang M, Park S. Repeatability of OCT Angiography Retinal Vascular Density Measurement in Retinal Vascular Disease. Poster presented at: ARVO; 2018; Honolulu, Hawaii.

98

Vessel Density Maps



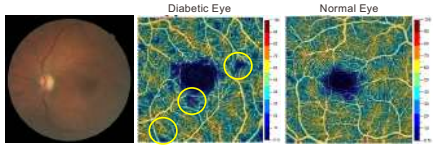
- Computes the percentage of area occupied by OCTA-detected vasculature based on the
  - Retina
    - Superficial vascular complex
    - Deep vascular complex
  - Optic Disc
    - Radial peripapillary capillary slab
- Highly repeatable including in diseased eyes[1]

1. Emami-Naeini P, Chang M, Park S. Repeatability of OCT Angiography Retinal Vascular Density Measurement in Retinal Vascular Disease. Poster presented at: ARVO; 2018; Honolulu, Hawaii.

99

Identify Early Vascular Changes in Diabetic Eyes

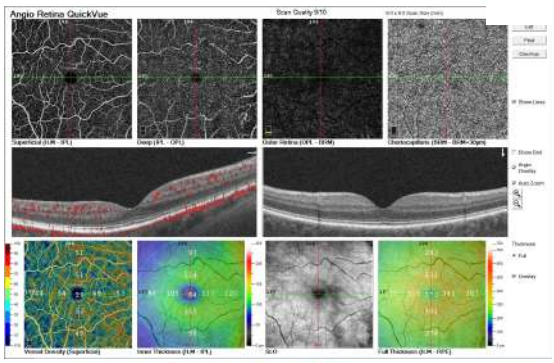
Quantitative OCTA parameters reveal subclinical macular vasculature change in diabetic eyes that do not manifest clinical retinopathy.[2]



2. Alibhai, Agha & M. Moult, Eric & Shahzad, Rida & Rebhun, Carl & Moreira-Neto, Carlos & McGowan, Mitchell & Lee, Diane & Lee, Byungkun & Baumal, Caroline & Witkin, Andre & Reichel, Elias & Duker, Jay & G. Fujimoto, James & K. Waheed, Nadia. (2017). Quantifying Microvascular Changes Using OCT Angiography in Diabetic Eyes without Clinical Evidence of Retinopathy. Ophthalmology Retina. 2. 10.1016/j.oret.2017.09.011.
Images courtesy of *Julie Rodman, OD, FAAO*

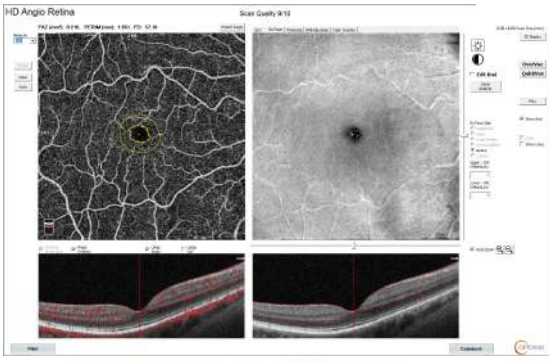
100

What is Normal



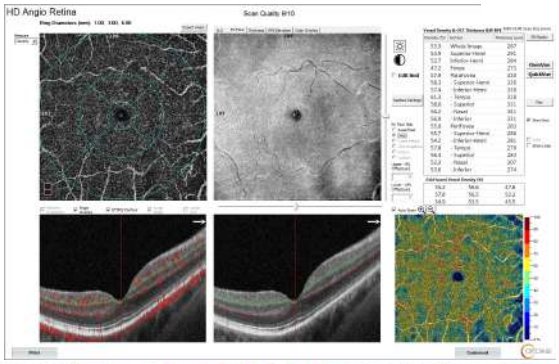
101

What is Normal - FAZ



102

What is Normal – Vessel Density



103

Identify Early Vascular Changes in Diabetic Eyes

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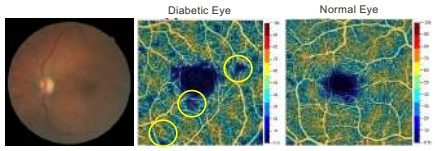
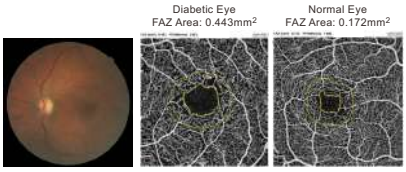


2. Alibhai, Agha & M. Moult, Eric & Shahzad, Rida & Rebhun, Carl & Moreira-Neto, Carlos & McGowan, Mitchell & Lee, Diane & Lee, Byungkun & Baumal, Caroline & Wilkin, Andre & Reichel, Elias & Duker, Jay & G. Fujimoto, James & K. Waheed, Nadia. (2017). Quantifying Microvascular Changes Using OCT Angiography in Diabetic Eyes without Clinical Evidence of Retinopathy. Ophthalmology Retina. 2. 10.1016/j.oret.2017.09.011.
Images courtesy of Julie Rodman, OD, FAAO

104

Identify Early Vascular Changes in Diabetic Eyes

Patients with DM more likely to have a larger FAZ than healthy eyes.[3]

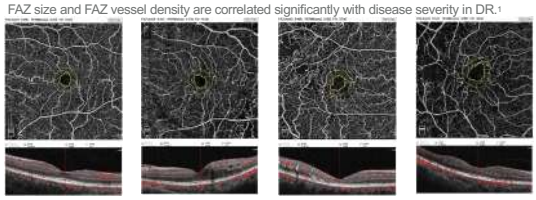


3. Di, G., Weihong, Y., Xiao, Z. et al. Graefes Arch Clin Exp Ophthalmology (2016) 254: 873.
Images courtesy of Julie Rodman, OD, FAAO.

105

Aid in Disease Severity Assessment with FAZ Measurements

FAZ size and FAZ vessel density are correlated significantly with disease severity in DR.[1]

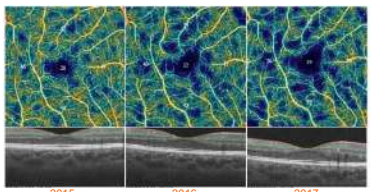


1. Nesper PL, Roberts PK, Onishi AC, et al. Quantifying Microvascular Abnormalities With Increasing Severity of Diabetic Retinopathy Using Optical Coherence Tomography Angiography. Investigative Ophthalmology & Visual Science. 2017;58(6):BIO307-BIO315. doi:10.1167/iovs.17-21787.

106

Assess Disease Progression with Multiscan View

Vessel Density Decreases Significantly with Disease Severity[4]

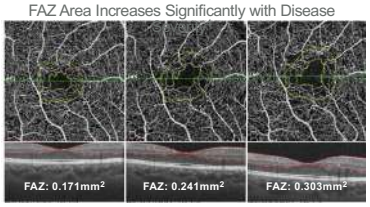


4. Nesper PL, Roberts PK, Onishi AC, et al. Quantifying Microvascular Abnormalities With Increasing Severity of Diabetic Retinopathy Using Optical Coherence Tomography Angiography. Investigative Ophthalmology & Visual Science. 2017;58(6):BIO307-BIO315. doi:10.1167/iovs.17-21787.

107

Assess Disease Progression with Multiscan View

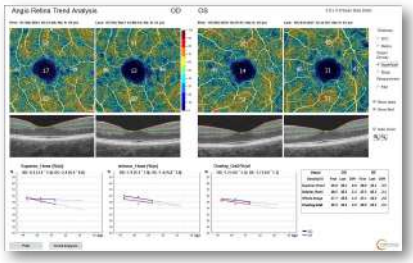
FAZ Area Increases Significantly with Disease



4. Nesper PL, Roberts PK, Onishi AC, et al. Quantifying Microvascular Abnormalities With Increasing Severity of Diabetic Retinopathy Using Optical Coherence Tomography Angiography. Investigative Ophthalmology & Visual Science. 2017;58(6):BIO307-BIO315. doi:10.1167/iovs.17-21787.

108

OU Vessel Density Trend Report



109

OU Retina Thickness Trend Report


Assessment of capillary dropout in the superficial retinal capillary plexus by optical coherence tomography angiography in the early stage of diabetic retinopathy

110

OCT-A in our clinic

Indications:

AMD – dry vs. wet
Diabetics -
- is there neo?
- is their non-perfusion (capillary dropout)?

Vein Occlusions
Glaucoma patients
- nerve perfusion?

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INTERPRETING RETINAL OCT'S & INTRODUCING OCT-ANGIOGRAPHY

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Assistant Dean for Clinical Care
Director of Continuing Education
Chief of Specialty Care Clinics
Oklahoma College of Optometry
lighthiz@nsuok.edu

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