OCT Grand Rounds

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- I do not have any relevant financial relationships to disclose.
- The content and format of this course is presented without commercial bias and does not claim superiority of any commercial product or service.

Ground Rules…

- References/sources available if you want them…
- 139 articles used for this presentation…
- I'm not perfect…
- Please email me with questions:
  - cborgman@sco.edu

OCT & Retrograde Degeneration

Retrograde vs. Anterograde degeneration?

Retrograde:
Cell bodies → RGC's in retina
Synapse → LGN

LGN → RGC's = retrograde

Ex: Compression, TON, MS, etc.

Anterograde:
Cell bodies: RGC's in retina
Synapse: LGN

RGC's → LGN = anterograde

Ex: Glaucoma

Case #1:

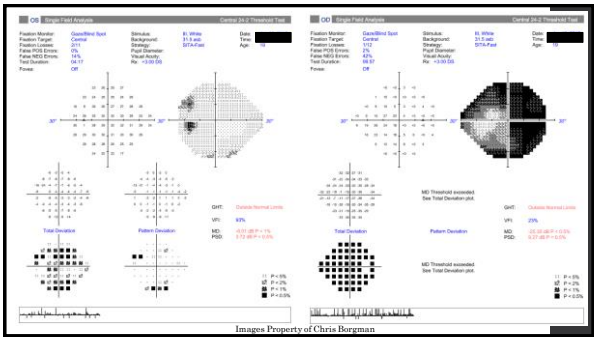
- Courtesy of Rena Lepine, OD

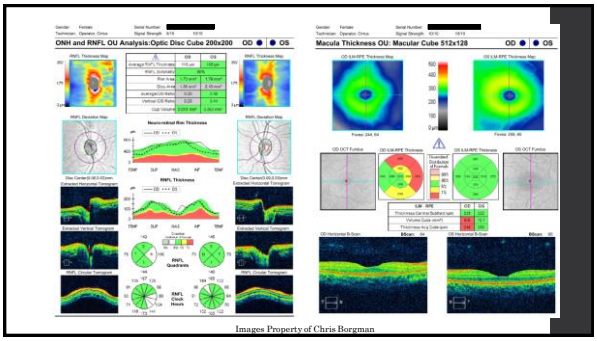
Case history…

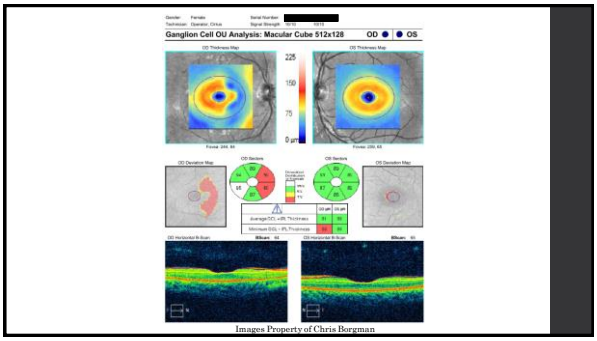
- 19 yo AAF
- CC: "blurry vision"
- HPI: OD only, constant, onset 2 months (?), (+)glare noted, (-)trauma, (-) relief with Visine drops, (+)frontal HA's started about same time, (-)relief with ibuprofen
- POH: glasses only
- PMH: unremarkable
- Meds: Ibuprofen PRN
- Allergies: nickel
- SH: denies all, (-)pregnant
- BP: 128/78

Exam…

- BCVA: 20/25+ OD, 20/20 OS
- Pupils: PERRL, (+)APD OD
- EOM's: Full OU
- CVF: sup temp defect OD, FTFC OS
- Cover Test: ortho @ D & N
- Color: very reduced OD, normal OS
- SLE: unremarkable OU
- DFE: see pics
- Tonometry: 16 mmHg OU with Goldman







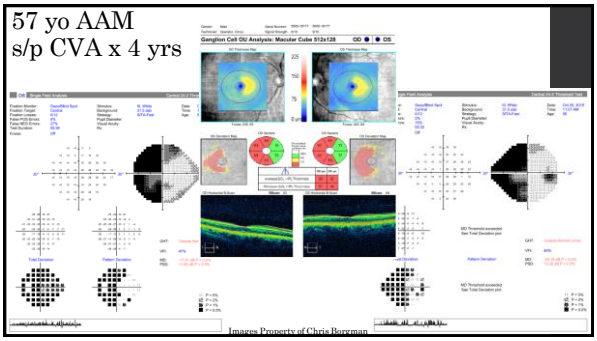
Workup/outcome…

- Brain/orbit MRI (with and without contrast) → WNL
- Neurology consult → monitor patient only x 2-3 months
  - Clinically isolated incident per neurologist → not enough for MS diagnosis at that time
- Further labwork ordered → pt no-showed to blood draw
  - CBC c diff
  - NMO IgG
  - RPR
  - FTA-ABS
  - Lyme titer
  - ACE
  - ANA
  - Vit B deficiencies
  - Folic acid levels

- VEP consideration???
- Pt lost to followup/no-showed…

Ganglion Cell Analyses in Neuro Cases

57 yo AAM
s/p CVA x 4 yrs



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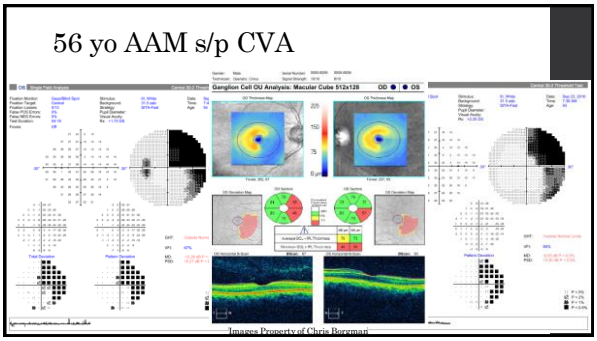
56 yo AAM s/p CVA



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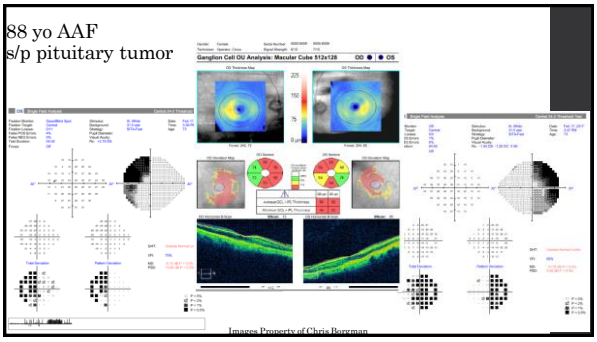
88 yo AAF
s/p pituitary tumor



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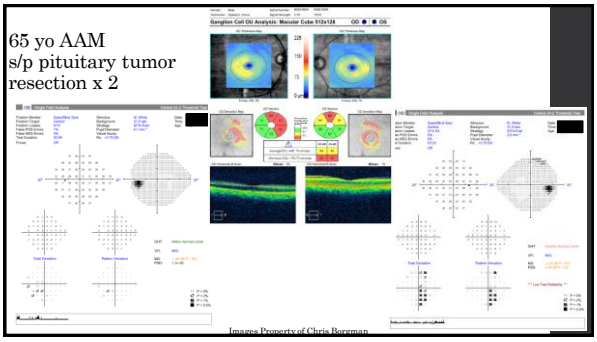
65 yo AAM
s/p pituitary tumor resection x 2



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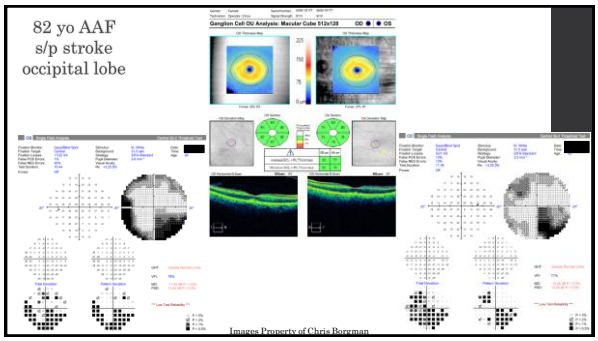
82 yo AAF
s/p stroke
occipital lobe
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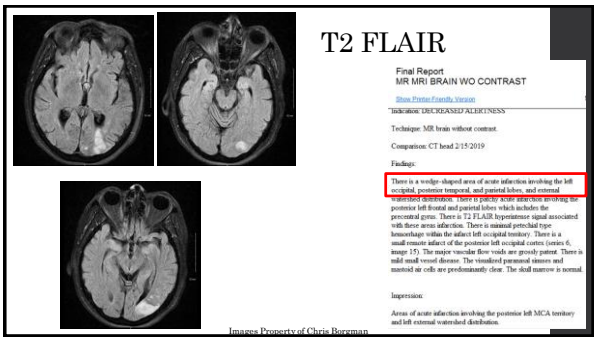
T2 FLAIR
Final Report
MR MRI BRAIN WO CONTRAST
Indication: DECREASED ALERTNESS
Technique: MR brain without contrast.
Comparison: CT head 2/15/2019
Findings:
There is a wedge-shaped area of acute infarction involving the left occipital, posterior temporal, and parietal lobes, and external watershed distribution. There is patchy acute infarction involving the posterior left frontal and parietal lobes which includes the precentral gyrus. There is T2 FLAIR hyperintense signal associated with these areas infarction. There is minimal petechial type hemorrhage within the infarct left occipital territory. There is a small remote infarct of the posterior left occipital cortex (series 6, image 15). The major vascular flow voids are grossly patent. There is mild small vessel disease. The visualized paranasal sinuses and mastoid air cells are predominantly clear. The skull marrow is normal.
Impression:
Areas of acute infarction involving the posterior left MCA territory and left external watershed distribution.
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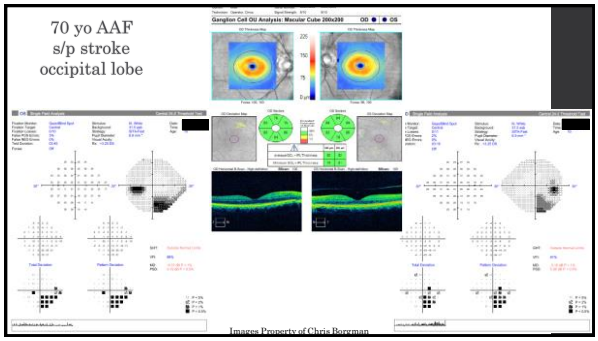
70 yo AAF
s/p stroke
occipital lobe
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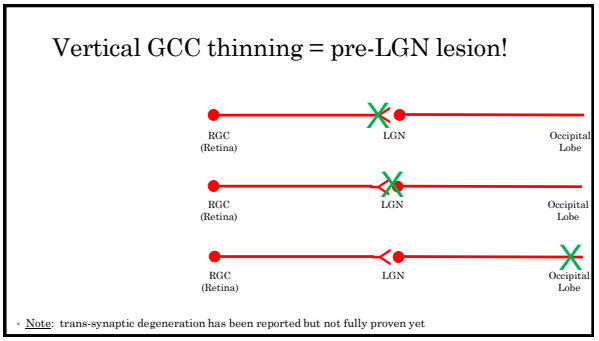
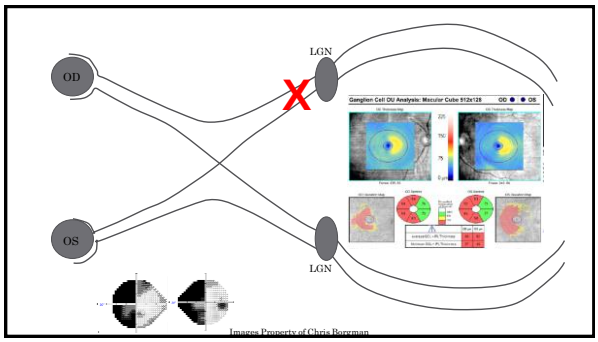

Vertical GCC thinning = pre-LGN lesion!
RGC
(Retina)
LGN
Occipital
Lobe
RGC
(Retina)
LGN
Occipital
Lobe
RGC
(Retina)
LGN
Occipital
Lobe
Note: trans-synaptic degeneration has been reported but not fully proven yet


OD
OS
LGN
LGN
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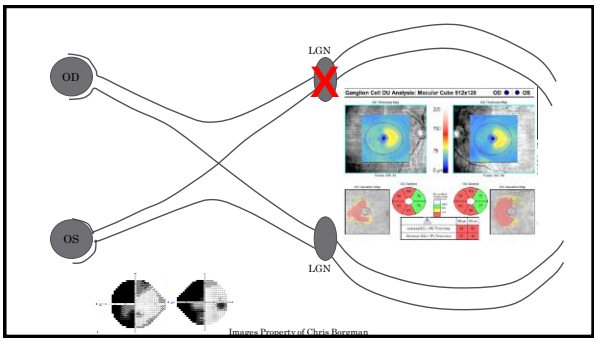
OD
OS
LGN
LGN
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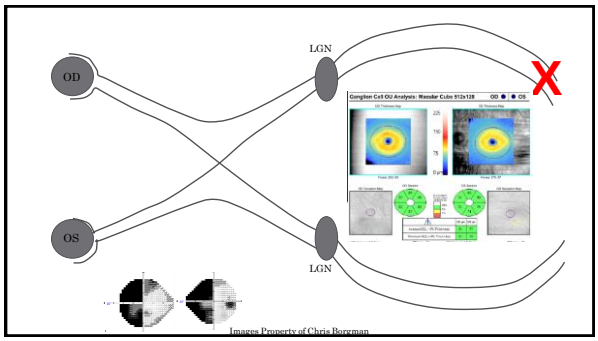

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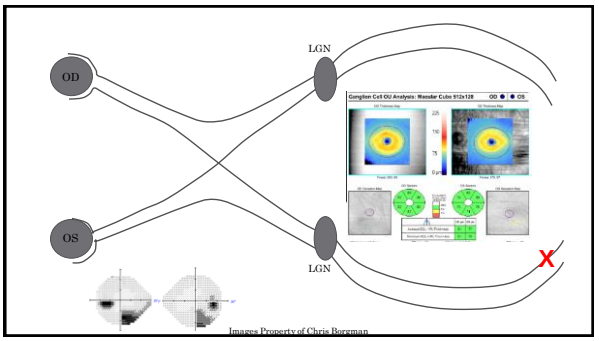

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Case

- 55 yo female
- CC: "glaucoma suspect – repeat testing"
- HPI: OD>OS, onset 5-6 years ago, no Tx at this time, (-)FHx glaucoma, vision stable OU per patient
- POH: glaucoma suspect OD>OS
- PMH: nasopharyngeal carcinoma at age 44, s/p chemo/radiation/resection
- Meds: multivitamin
- ALL: NKDA

Exam…

- VA: 20/20 OD, 20/20 OS
- Pupils: PERRL, (-)APD
- CVF: FTFC OU
- EOM: FROM OU
- SLE: normal OU
- DFE: see photos of nerves
- IOP: 12 OD, 15 OS via iCare


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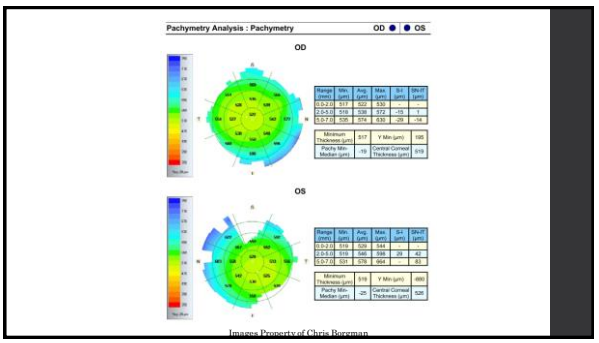

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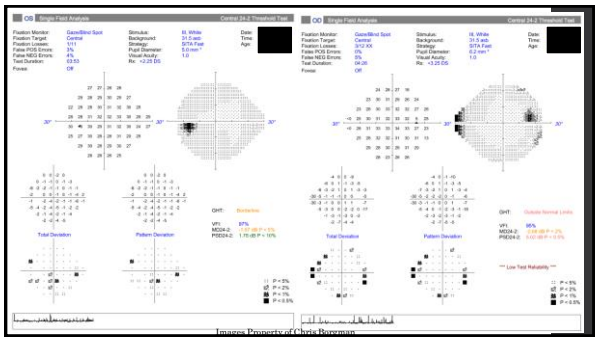

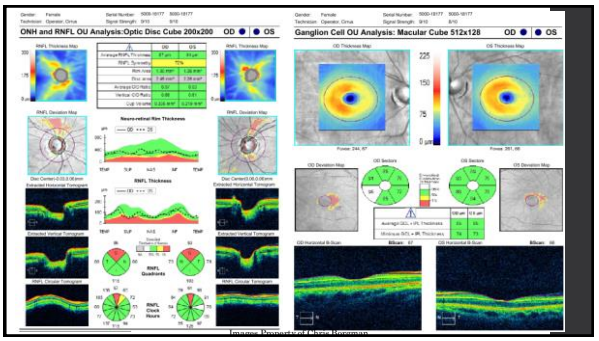

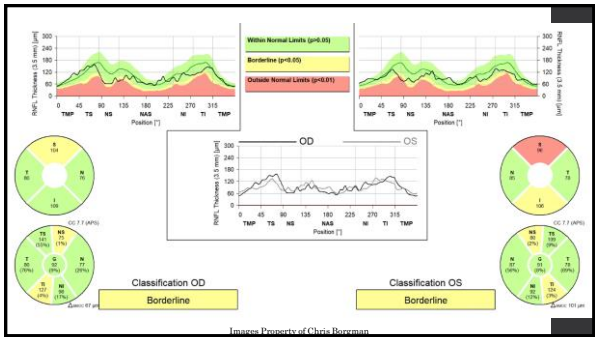

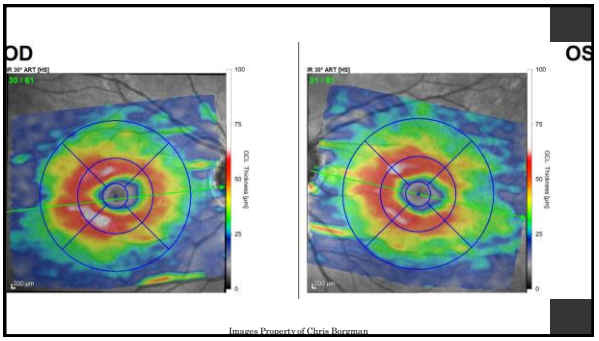

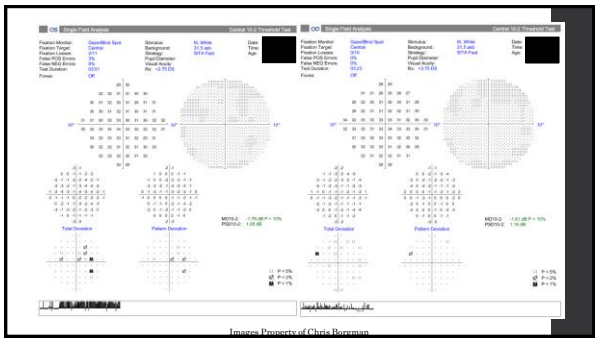

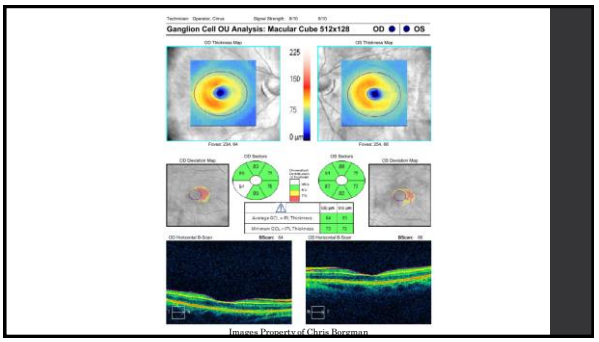

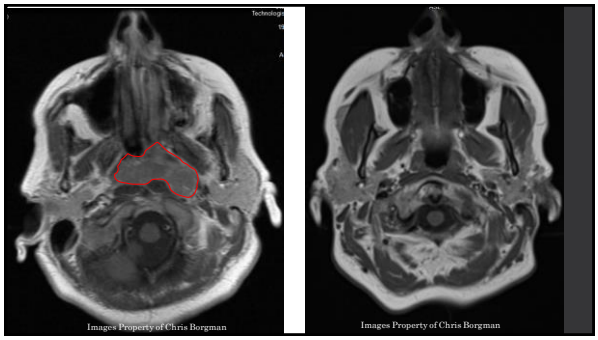

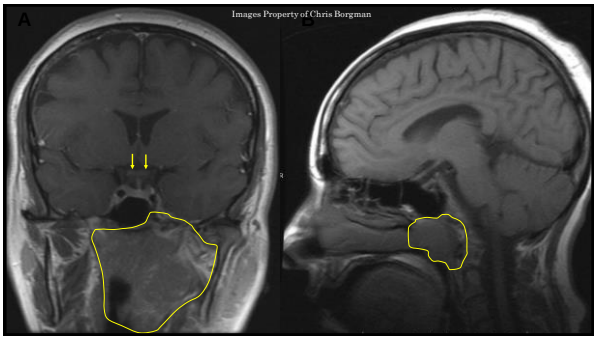

Final Diagnosis…

- Dx = Collateral radiation damage to optic tract
- None of the MRI scans showed carcinoma/tumor close enough to optic tract to cause compression…
- Occam's Razor → the most likely explanation is most often the correct one
- Radiation Toxicity to Optic Tract

HEAT CHECK!

Quick Case Topic…

Case…

- 46 yo AAF
- CC: "reduced vision"
- HPI: OS only, slowly getting worse, central vision>>peripheral vision, spot just off of central vision OS, (-)trauma
- POH: unremarkable; first eye exam "in a long time"
- PMH: T2DM x 16 yrs, unknown A1c, last BG was 500 but doesn't check regularly, was in diabetic ketoacidosis 3 weeks ago, PCP recommended eye exam at last PCP visit 2 weeks ago; HTN x 16 yrs, unknown last BP
- Meds: metformin, insulin, Onglyza, metoprolol, losartan
- Allergies: NKDA
- SH: unremarkable

Exam…

- VAcc: 20/20 OD, 20/25+ OS
- Pupils: PERRL, (-)APD
- CVF: FTFC peripherally OU, central depressions OU?
- EOMs: FROM OU
- SLE: unremarkable OU
- DFE: see photos
- IOP: 20 OD, 22 OS via Goldman


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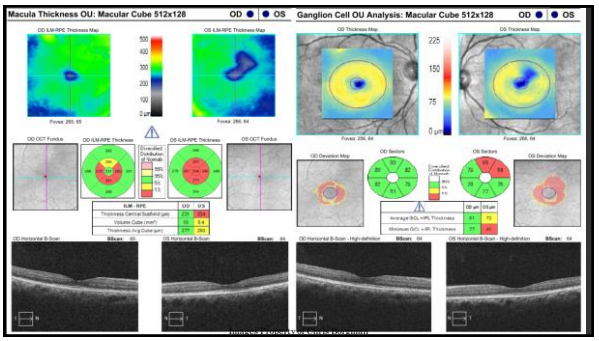
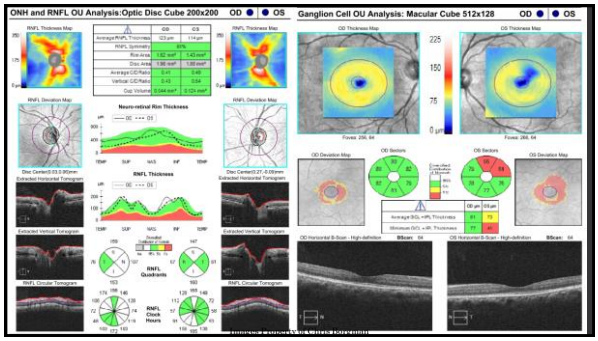
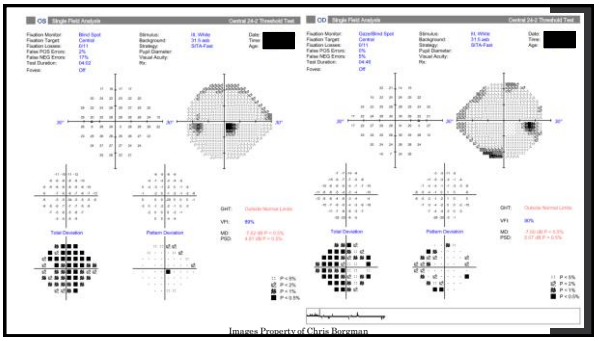

Macula Thickness OU: Macular Cube 512x128
Ganglion Cell OU Analysis: Macular Cube 512x128


ONH and RNFL OU Analysis:Optic Disc Cube 200x200
Ganglion Cell OU Analysis: Macular Cube 512x128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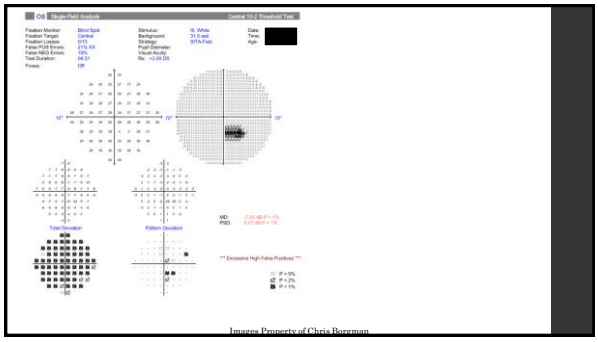
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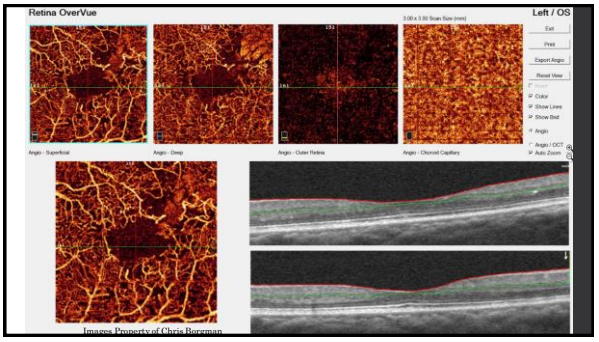
Retina OverVue
Left / OS
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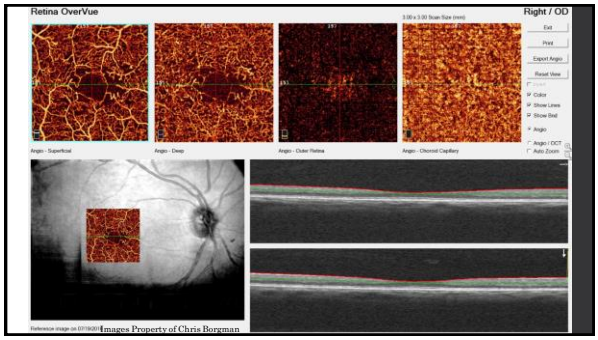

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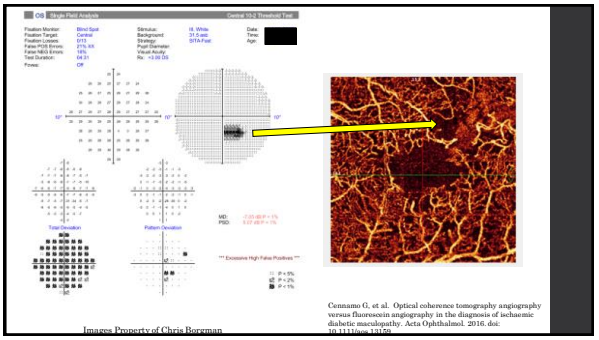
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Cennamo G, et al. Optical coherence tomography angiography versus fluorescein angiography in the diagnosis of ischaemic diabetic maculopathy. Acta Ophthalmol. 2016. doi: 10.1111/aos.13159

OCT & Ocular Torsion

Case

- 58 yo AAM
- CC: "double vision"
- HPI: started 4 days ago, vertical/oblique diplopia, (-)trauma, diplopia goes away when covering either eye
- POH: unremarkable
- PMH: hypercholesterolemia
- Meds: rosuvastatin
- Allergies: NKDA

Exam…

- VAsc: 20/20 OD, 20/20 OS
- Pupils: PERRL, (-)APD
- CVF: FTFC OU
- EOM: FROM OU, OS overshoot in attempted right gaze
- Cover Test: 4^ LHT primary gaze
- SLE: normal OU
- DFE: normal OU
- IOP: 16 OD, 16 OS with Goldman

Notice Right Head Tilt

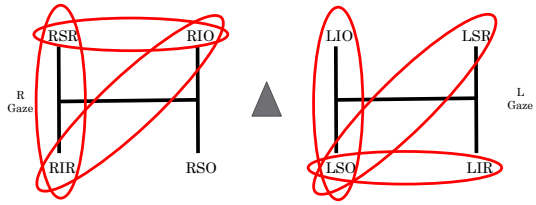
Sensorimotor Examination

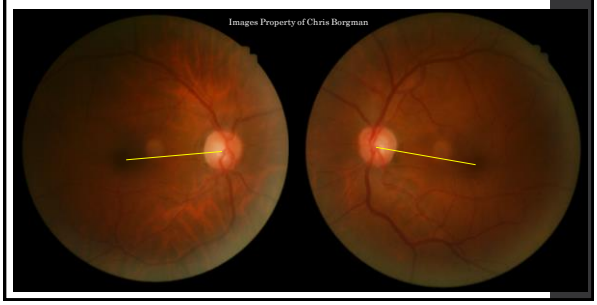
2^ LHT		6^ LHT
6^ LHT	4^ LHT	2^ LHT

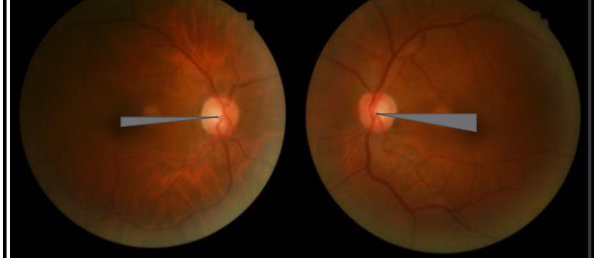
Double Maddox Rod:
OD: 0°
OS: 6° excyclotorsion

Upright/Supine Test:
Upright: 4^ LHT
Supine: 4^ LHT

Park's 3 Step



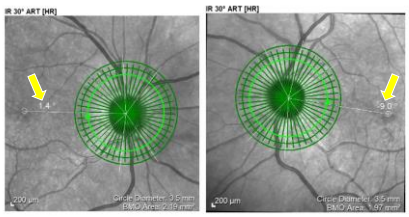




Tan (Θ) = opposite/adjacent
Tan (Θ) = 0.21 / 2.20
Tan (Θ) = -5.45°

Tan (Θ) = opposite/adjacent
Tan (Θ) = 0.40 / 2.27
Tan (Θ) = -9.99°

OD



OS

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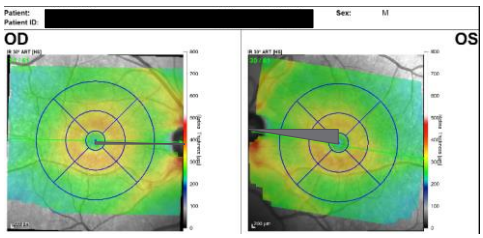

Tan (Θ) = opposite/adjacent
Tan (Θ) = 0.05 / 2.03
Tan (Θ) = +1.41°

Tan (Θ) = opposite/adjacent
Tan (Θ) = 0.34 / 2.02
Tan (Θ) = -9.55°

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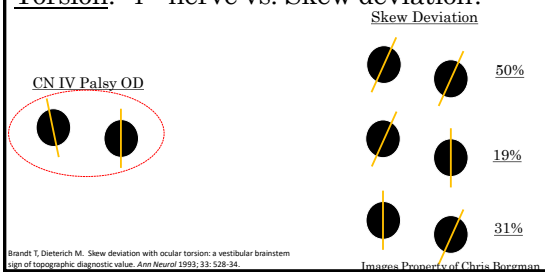
Torsion: 4th nerve vs. Skew deviation?



Brandt T, Dieterich M. Skew deviation with ocular torsion: a vestibular brainstem sign of topographic diagnostic value. *Ann Neurol* 1993; 33: 528-34.

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OCT and Ocular Torsion

- OCT can be an objective way to measure ocular torsion
  - Fundus photos are also considered objective measurement
- DMR is considered subjective measurement
- It is common for subjective and objective measures of torsion to be different!
  - Subjective torsion ≠ objective torsion
- Considered a new way to assess ocular torsion
- Main uses:
  - Acute brainstem pathology leading to vertical diplopia
  - Examples → acute CN IV palsies and skew deviations

- Borgman CJ, Haynes JA. Measuring acquired ocular torsion with optical coherence tomography. Clin Exp Optom. 2021;104:132-4.
- Borgman CJ, Follansbee CJ. Degree of excyclotorsion in acquired trochlear nerve palsy. Clin Exp Optom. 2020;103:550-1.
- Yamadeera K, et al. A novel method for evaluation of ocular torsion angle by optical coherence tomography. Trans Vis Sci Tech. 2020;9:1-6.
- Kanku MS, et al. Cyclotorsion measurements on scanning laser ophthalmoscopy imaging compared with fundus photography in patients with fourth nerve palsy and health controls: CyCLOW-IV Study. J Neuro-Ophthalmol. 2020;00:1-7

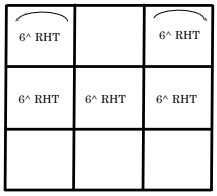
Case

- 60 yo AAM
- CC: double vision since stroke
- HPI: vertical diplopia x 1 month, brainstem CVA x 1 month ago
- POH: mild cataracts OU, LEE x 1 year ago
- PMH: HTN, unknown BP ("it was high"); T2DM, unknown BG ranges/levels ("it was high too")
- Meds: metformin, glipizide, atenolol, lisinopril
- Allergies: NKDA
- SH: unremarkable

Exam…

- VAcc: 20/20 OD, 20/20 OS
- Pupils: PERRL, (-)APD
- CVF: FTFC OU
- EOMs: FROM OU but clear right hypertropia noted
- Cover Test: 6^ RHT in primary gaze
- SLE: grossly normal OU, mild cataracts OU
- DFE: unremarkable
- IOP: 12 OD, 12 OS via Goldman

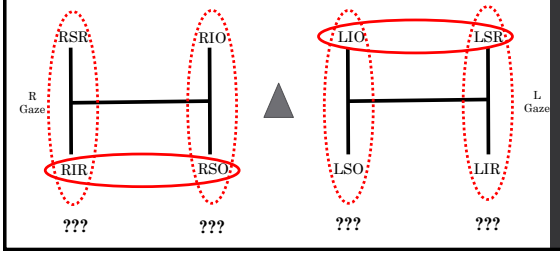
Sensorimotor Examination

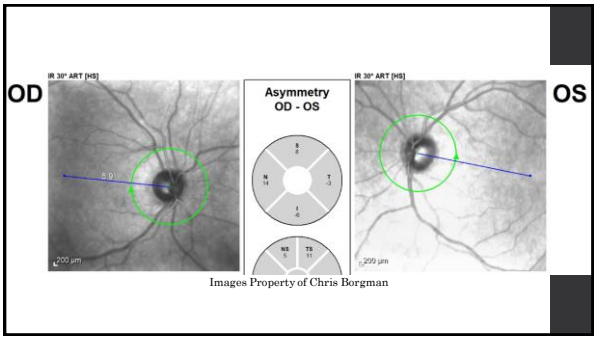


Double Maddox Rod:
OD: 3° incyclotorsion
OS: 6° excyclotorsion

Upright/Supine Test:
Upright: 6^ RHT
Supine: 1^ RHT

Park's 3 Step





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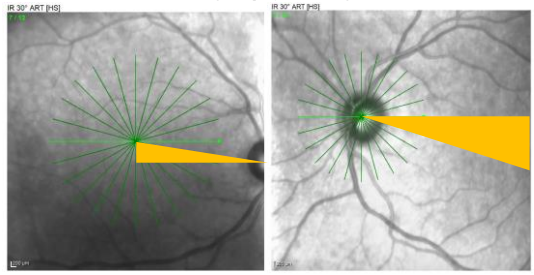
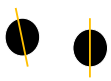


Tangent (θ) = 0.47 / 2.97 = +9.0°

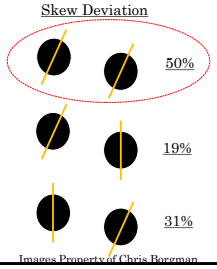
Tangent (θ) = 1.23/ 3.80 = -17.9°

Torsion: 4th nerve vs. Skew deviation?

CN IV Palsy OD



Skew Deviation



Brandt T, Dieterich M. Skew deviation with ocular torsion: a vestibular brainstem sign of topographic diagnostic value. *Ann Neurol* 1993; 33: 528-34.

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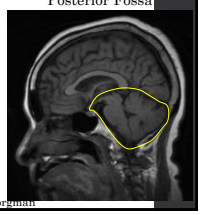
Diagnosis = Skew Deviation

- Defn: Disruption of otolith input to brainstem EOM subnuclei
- Laymen's terms: vertical EOM deviation due to unhooking VOR
- Lesion location(s) → anywhere in posterior fossa!
  - Peripheral vestibular system
  - Pons
  - Medulla
  - Midbrain
  - Inferior thalamus
  - Cerebellum (rarely)
- Need to get an MRI of brainstem!

Posterior Fossa



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OCT & Retina Confusion

Case

- 63 yo AAM
- CC: "routine exam; do I need glasses?"
- HPI: adequate vision OU per patient, maybe some mild blur?, never had eye exam before
- POH: unremarkable
- PMH: HTN – well controlled
- Meds: lisinopril
- Allergies: NKDA
- SH: unremarkable

Exam…

- VA: 20/30 OD, 20/30 OS
- Pupils: PERRL, (-)APD
- EOM: FROM OU
- CVF: FTFC OU
- SLE: normal OU
- DFE: see photos/OCTs
- IOP: 18 OD, 18 OS via iCare

Irregular foveal light reflexes OU??

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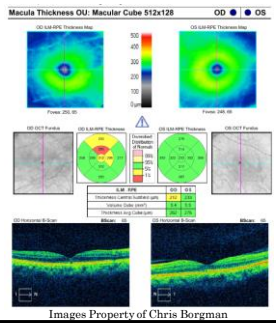

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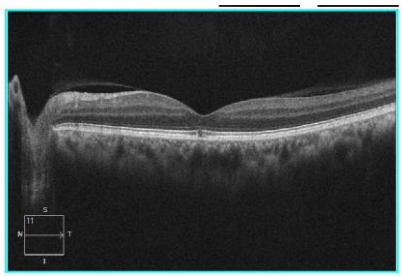

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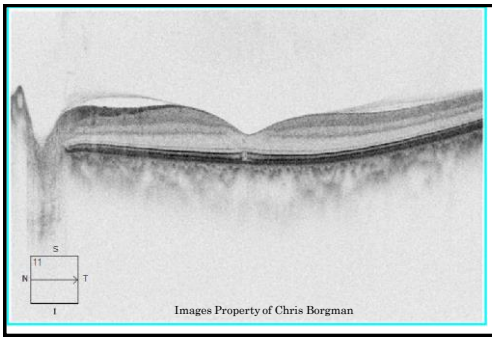

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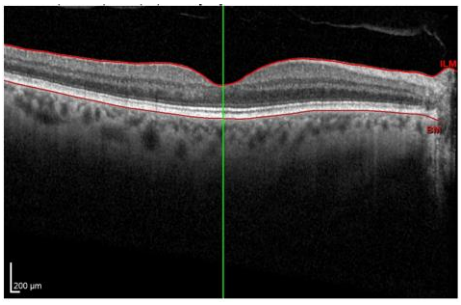
How did this happen?

- Upon further questioning to patient…
- Patient: "Man, when I was 11 years old I saw the original Superman movie – and Superman got his strength from the sun-- so I stared at the sun about 5 times for as long as I could in hopes that I'd get X-ray vision like Superman did!....is that what caused what you're seeing??"
- Me: "Yes!"

Final Dx → Solar Retinopathy OU

How about this OCT scan?

- Is this Solar Retinopathy also?



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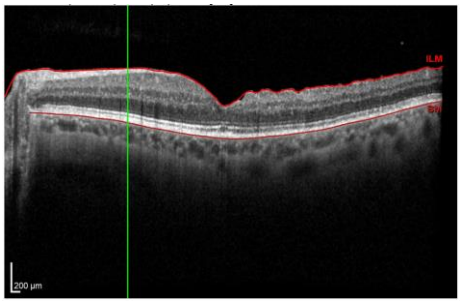

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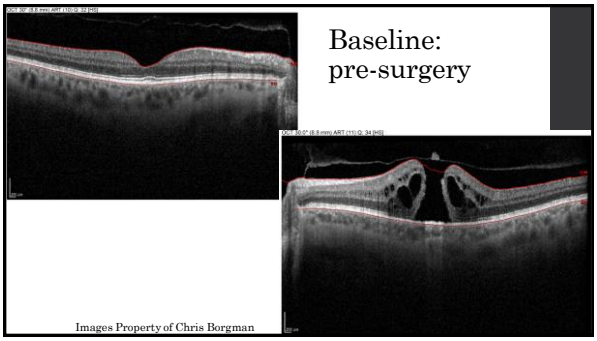
Baseline: pre-surgery



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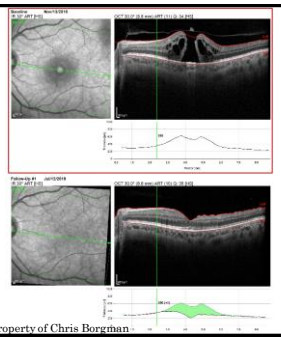
Pre- and Post-Surgery



Images Property of Chris Borgman

Macular Hole Repair Closure Patterns

n=253 eyes

Rossi T, et al. Macular hole closure patterns: an updated classification. *Graefes Arch Clin Exp Ophthalmol*. 2020;258:2629-2638.

Another Case of Pseudo-Solar Retinopathy…

- s/p macular hole repair

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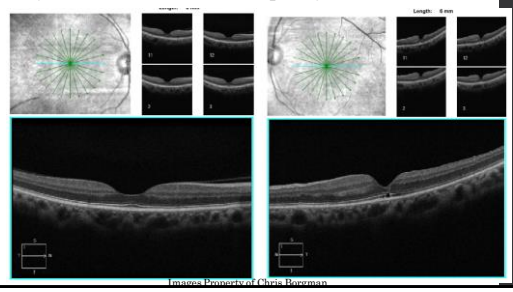
Very similar to solar retinopathy, but it's not!



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New Case

New Case/Topic

- 26 yo HM, 4th year SCO optometry student
- CC: "we were playing around on the OCT and my retinas look weird"
- HPI: OD=OS, denies symptoms, unknown onset
- POH: EBMD → recurrent RCE in past, irregular astigmatism → tried scleral CL's but unable to tolerate
- PMH: s/p kidney transplant 2' Alport syndrome, sensorineural hearing loss
- Meds: lisinopril
- Allergies: NKDA
- SH: unremarkable

Case:

- Best corrected VA: 20/30 OD, 20/40 OS
- Pupils: PERRL, (-)APD
- CVF: FTFC OU
- EOM: FROM OU
- CT: ortho distance/near
- SLE: irregular astigmatism, EBMD → RCE in past
- DFE: see photos
- IOP: 18 OD, 18 OS

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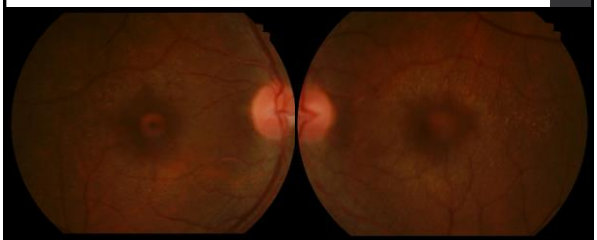

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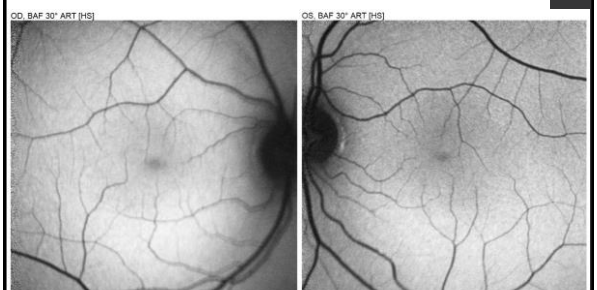

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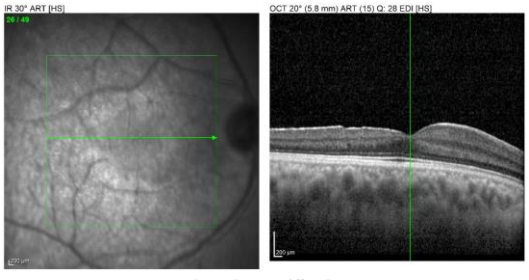

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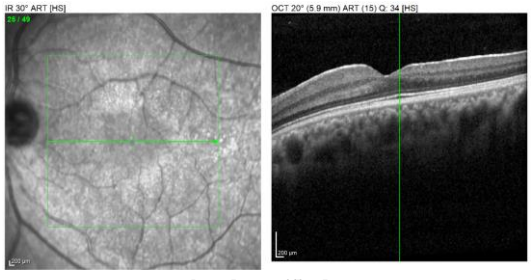

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Alport Syndrome

- Inherited/genetic X-linked collagen IV disorder
- Pathophysiology: defective or absent collagen IV in basement membranes throughout body
- Associated with:
  - Renal failure (99%)
  - Hearing loss (82.5%)
  - Ocular findings (44-81%)

- Nozu K, Nakanishi K, Abe Y, et al. A review of clinical characteristics and genetic backgrounds in Alport syndrome. *Clin Exp Nephrol* 2019; 23: 158-68.
- Savige J, Colville D. Ocular features aid the diagnosis of Alport syndrome. *Nat Rev Nephrol* 2009; 5: 356-60.
- Savige J, Sheth S, Leys A, et al. Ocular features in Alport syndrome: pathogenesis and clinical significance. *Clin J Am Soc Nephrol* 2015; 10: 703-9.

Ocular findings…

- 70% males vs. 15% females
- **Temporal retinal thinning (81%)
- Dot-and-fleck retinopathy (13-70%)
- Lozenge's sign/dull macular reflex (19%)
- Lenticonus (2-50%)
- Other ocular findings possible:
  - Keratoconus, RCE, posterior polymorphous K dystrophy
  - Iris atrophy
  - Cataracts

- Savige J, Colville D. Ocular features aid the diagnosis of Alport syndrome. *Nat Rev Nephrol* 2009; 5: 356-60.
- Ahmed F, Kamae KK, Jones DJ, et al. Temporal macular thinning associated with X-linked Alport syndrome. *JAMA Ophthalmol* 2013; 131: 777-82.
- Borgman CJ, et al. Temporal retinal thinning and increased foveal avascular zone blood vessel density in Alport syndrome: a case report. Clin Exp Optom. 2021 Feb. doi: 10.1080/08164622.2021.1880865.
- Savige J, Sheth S, Leys A, et al. Ocular features in Alport syndrome: pathogenesis and clinical significance. *Clin J Am Soc Nephrol* 2015; 10: 703-9.

Temporal retinal thinning

- **Most common ocular finding in X-linked Alport syndrome
  - AKA: "stair-case" thinning
- Temporal macula is ~59 µm thinner than nasal macula
- No significant effect on vision in general
- Predominantly affects superficial layers of retina
- Temporal retinal thinning → How? Why?
  - Idiopathic/unknown at this time
  - Believed to be related to underlying collagen IV dysfunction
  - Abnormal vitreoretinal traction?
  - Abnormal Muller cell adhesion?
  - Presumed congenital? Acquired seems unlikely…

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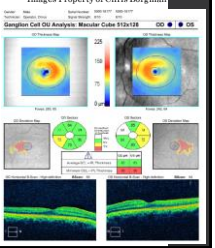
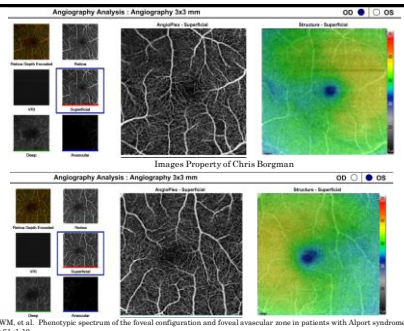


Enlarged vs. Absent FAZ's on OCT-A?

- Apparently both are possible in Alport Syndrome!

Hess K, Pfau M, Wintergerst MWM, et al. Phenotypic spectrum of the foveal configuration and foveal avascular zone in patients with Alport syndrome. *Invest Ophthalmol Vis Sci* 2020; 61 :1-10.

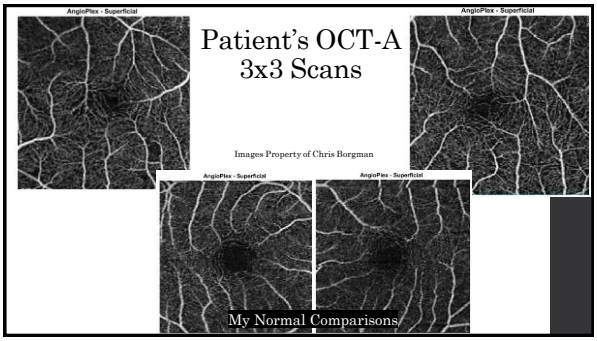
My Patient



Images Property of Chris Borgman

Hess K, Pfau M, Wintergerst MWM, et al. Phenotypic spectrum of the foveal configuration and foveal avascular zone in patients with Alport syndrome. *Invest Ophthalmol Vis Sci* 2020; 61 :1-10.

Patient's OCT-A 3x3 Scans



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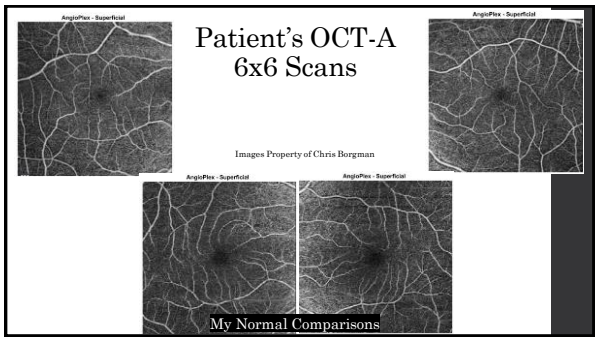
My Normal Comparisons



Patient's OCT-A 6x6 Scans

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My Normal Comparisons

New Case

Case

- 44 yo AAF
- CC: new onset diplopia → final diagnosis was CN VI palsy
- Ultimately diagnosed with MS!

- However, incidental retinal finding on DFE…..let's take a look!

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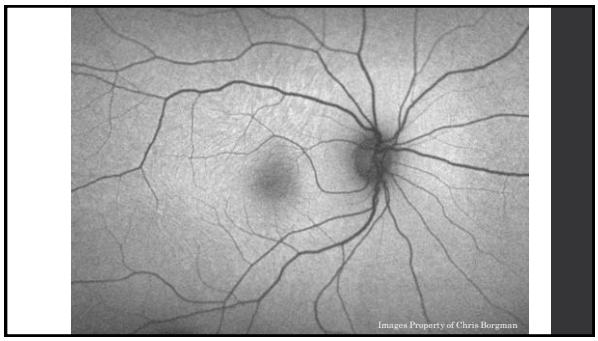
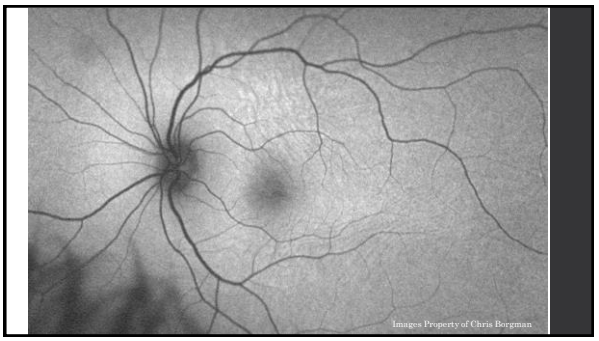
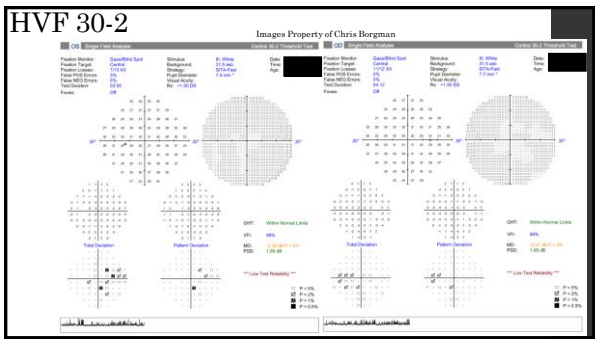
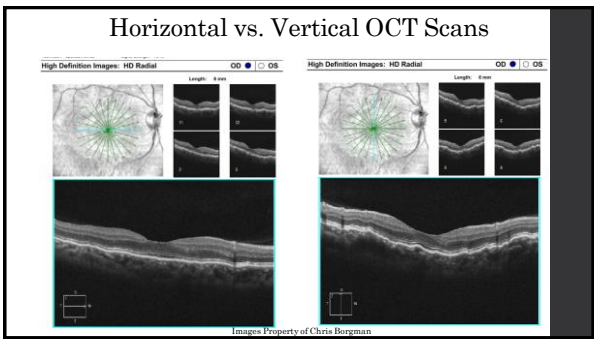




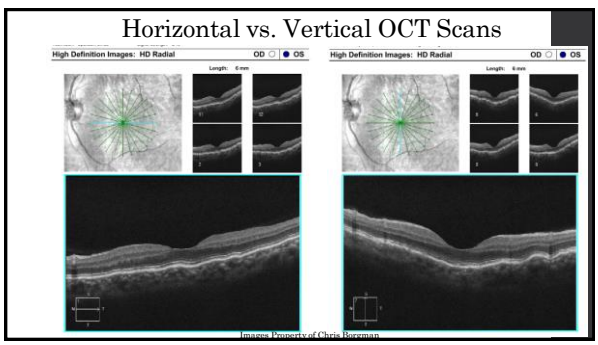
HVF 30-2



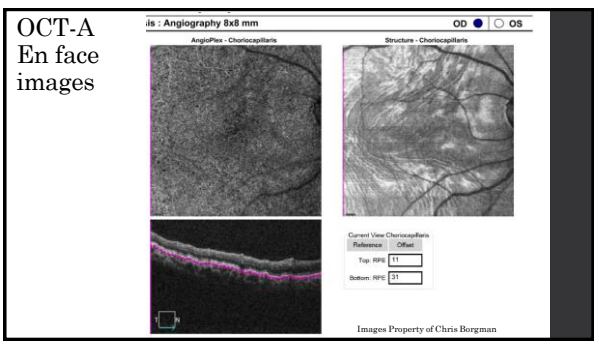
Horizontal vs. Vertical OCT Scans



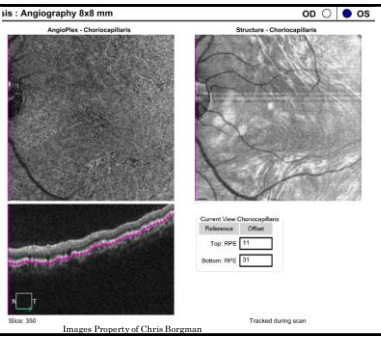
Horizontal vs. Vertical OCT Scans



OCT-A
En face
images



OCT-A
En face
images



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Chorioretinal Folds

- First documented by Nettles in 1884
- Striae/grooves/lines in posterior pole with numerous patterns possible
- Pseudo-sinusoidal undulations of inner choroid, Bruch's membrane and RPE = choroidal folds
  - If neurosensory retina involved then proper name → chorioretinal folds
- Alternating light-dark streaks usually present
- Underlying autoimmune condition has been identified in about 28% of cases
- Unilateral: 44% to 58% cases
- Variable visual acuity but usually near normal acuity
- Patient's usually asymptomatic
- MOA: largely idiopathic; not completely elucidated at this time

Bagnis A, et al. Chorioretinal folds: a proposed diagnostic algorithm. *Int Ophthalmol*. 2019;doi:10.1007/s10792-019-01083-y.

Common Associations

- HTN (47.5%)
- Hyperopia (45%)
- Known systemic autoimmune disease (28%)
- Idiopathic/Unknown (11-17%)

- Other reported assocations include:
  - Papilledema, optic neuritis, thyroid eye disease, CNVM, CSCR, choroidal nevi, orbital/choroidal tumors, surgical procedures, autoimmune diseases (RA, PMR, MS, VKH, etc), infectious causes (ie. Lyme disease)

Olsen TW, et al. Chorioretinal folds: Associated disorders and a related maculopathy. *Am J Ophthalmol*. 2014;157:1038–1047.

Best Tools to Identify Choroidal Folds

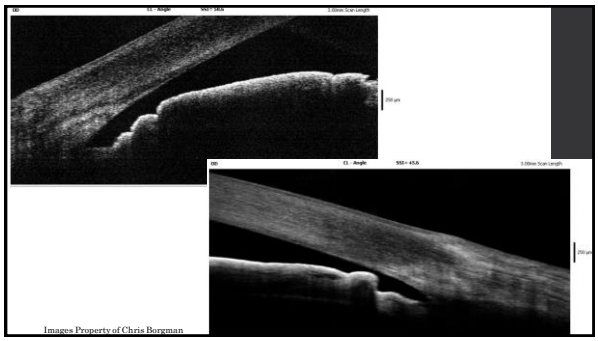
- OCT***
- OCT-A
- FAF
- IVFA
- Retinal Photos

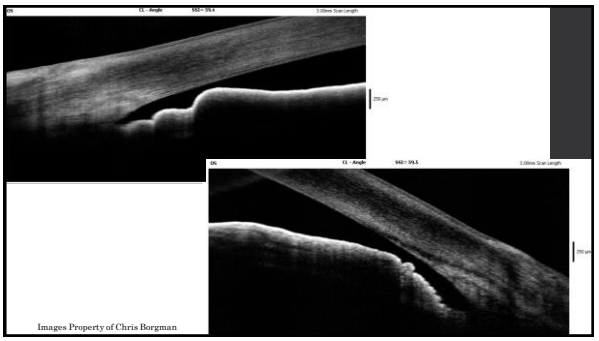
- Del Turco C, et al. Optical coherence tomography angiography features of chorioretinal folds: A case series. *Eur J Ophthalmol*. 2017;27:e35–e38.
- Giuffrè G, et al. Optical coherence tomography of chorioretinal and choroidal folds. *Acta Ophthalmol Scand*. 2007;85:333–336.
- Rosenfeld PJ, et al. Zeiss Angioplex spectral domain optical coherence tomography angiography: technical aspects. *Dev Ophthalmol*. 2016;56:18–29
- Bagnis A, et al. Chorioretinal folds: a proposed diagnostic algorithm. *Int Ophthalmol*. 2019;doi:10.1007/s10792-019-01083-y.

OCT &
Narrow Angle Glaucoma

Case

- 65 yo AAF
- CC: routine clinical exam"
- Upon SLE, noted pretty severe narrow angles per Von Herrick
- Gonio: no structures seen OU
- Additional testing possible?
  - Anterior segment OCT
  - Anterior segment ultrasound
- Is this pupillary block/narrow angles? Or plateau iris configuration?
- Is it time to refer for cataract surgery and/or LPI?





Plateau Iris Configuration (PIC)

- *"Classic teaching is that PIC cannot be diagnosed without first performing an iridotomy or iridectomy to rule out PB…there is no definitive criteria for diagnosing PIC on gonioscopy without a patent iridotomy or iridectomy present."*
  -- Crowell et al. *J Glaucoma*. 2020
- Can we use anterior segment OCT to diagnose PIC without iridotomy/iridectomy???

- Crowell EL, et al. Using anterior segment optical coherence tomography (ASOCT) parameters to determine pupillary block versus plaqueau iris configuration. *J Glaucoma*. 2020;29:1036-42.

OCT and the Iridocorneal Angle in Glaucoma

- Gonioscopy is still the gold standard!
  - OCT is a supplement, not a replacement!
- Specific/best measurements of anterior segment OCT to determine pupil block (PB; ie. narrow angles) vs. plateau iris configuration (PIC) are still being worked out
- Crowell et al. (2020) suggest two best parameters of PB vs. PIC to be:
  1. Lens/pupil size:
     - Horizontal> 4.1 mm = PIC
     - Vertical >3.8 mm = PIC
  2. Pupillary margin-center scleral spur length angles (PM-CSSL)
     - Nasal → <13.76° = PIC
     - Superior → <16.45° = PIC
     - Temporal → <18.39° = PIC
     - Inferior → <18.58° = PIC

- Triolo G, et al. The use of anterior-segment optical coherence tomography for the assessment of the iridocorneal angle and its alterations: update and current evidence. *J Clin Med*. 2021;10:1-11.
- Crowell EL, et al. Using anterior segment optical coherence tomography (ASOCT) parameters to determine pupillary block versus plaqueau iris configuration. *J Glaucoma*. 2020;29:1036-42.

Pupillary margin-center scleral spur length angles (PM-CSSL) → yellow angle

- Crowell EL, et al. Using anterior segment optical coherence tomography (ASOCT) parameters to determine pupillary block versus plaqueau iris configuration. *J Glaucoma*. 2020;29:1036-42.

Conclusion:
OCT for Pupil Block vs. Plateau Iris

- Need more studies…
- OCT might be key to differentiate these in the future before iridotomy/iridectomy performed
- I don't see gonio being replaced any time soon.
  - But OCT is a very good adjunct to gonio; I use it all the time!
- Stay tuned for future research!

Thanks!

- Questions? Accolades?
- cborgman@sco.edu

SOUTHERN COLLEGE OF OPTOMETRY

- Complaints?
- wmcgriff.@sco.edu