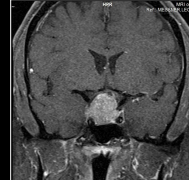


“Mind-Bending” Neuro-Oph Grand Rounds: “From the Chiasm & Beyond”



Leonard V. Messner, OD, FAAO
Professor of Optometry
Vice President for Strategy & Institutional Advancement
Illinois College of Optometry



1

Disclosure Statement

- King Devick Technologies (scientific advisory board)
- Heidelberg Engineering (professional advisory board)
- Horizon Therapeutics (professional advisory board)

All relevant relationships have been mitigated

2

Anatomy slides courtesy of Lorraine Lombardi, PhD



3

Key Points

- Neuroanatomical planes of the body
- Imaging techniques and scan selection
- Correlative neuro-anatomy and neuroradiology for visual pathway lesions
 - Chiasm
 - Retro-chiasm

4

Planes of the Body

- Axial
- Sagittal
- Coronal

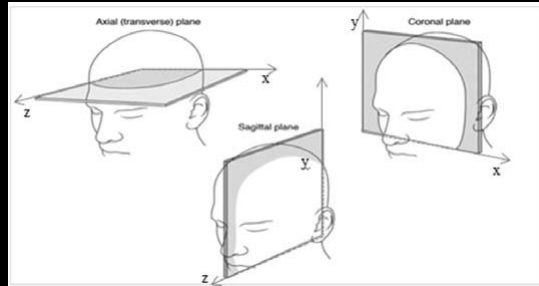
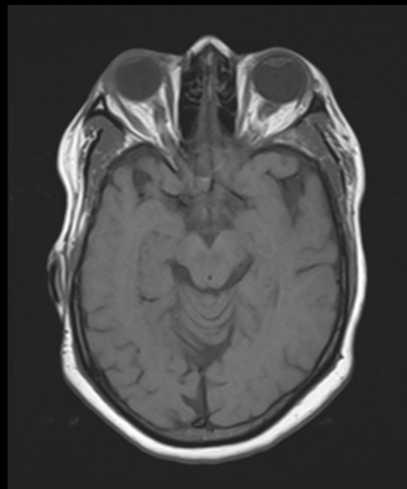


Image reference: https://www.researchgate.net/publication/280608869_Brain_MRI_literature_review_for_interdisciplinary_studies/figures?to=1

5

Axial

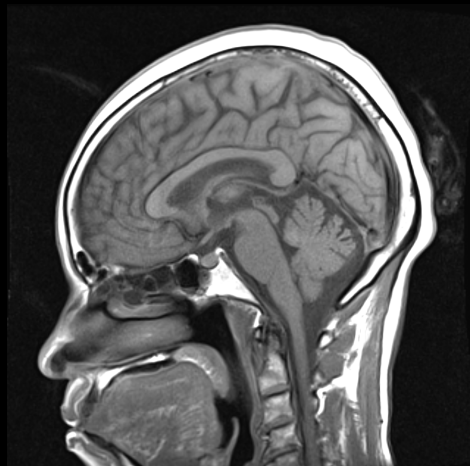
right



left

6

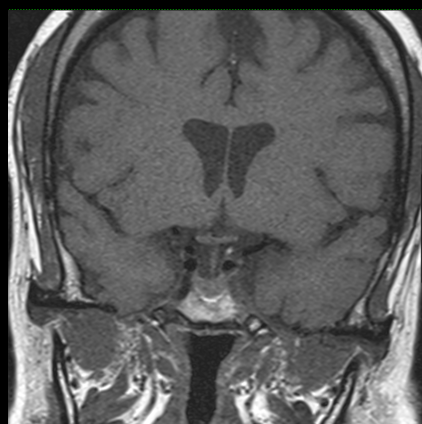
Sagittal



7

Coronal

right



left

8

Neuroimaging Studies

- Computed tomography (CT)
- Magnetic resonance imaging (MRI)

9

Ordering a Scan

- Scan selection (e.g. MRI, CT) and testing protocol:
 - Brain
 - Orbits
 - Pituitary/chiasm
- With / without contrast
- Clinical impression/question to be answered
- Medical history

10

COMPUTED TOMOGRAPHIC (CT) SCANNING

11

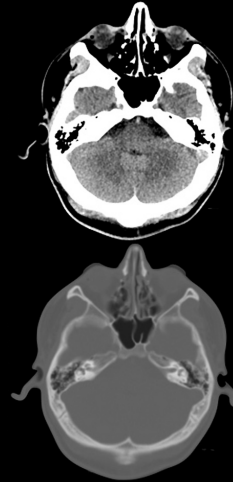
Background

- Increased absorption of x-rays by atoms of higher atomic # (Ca, I, Fe)
- Axial & coronal image planes
- Iodinated IV contrast
 - contraindicated for px's with hx of allergic rxn to previous contrast studies or shellfish, pregnancy or renal disease

12

CT “Windows”

- Brain / Soft Tissue
 - 50-350 HU (narrow window)
- Bone
 - 400-2000 HU (wide window)

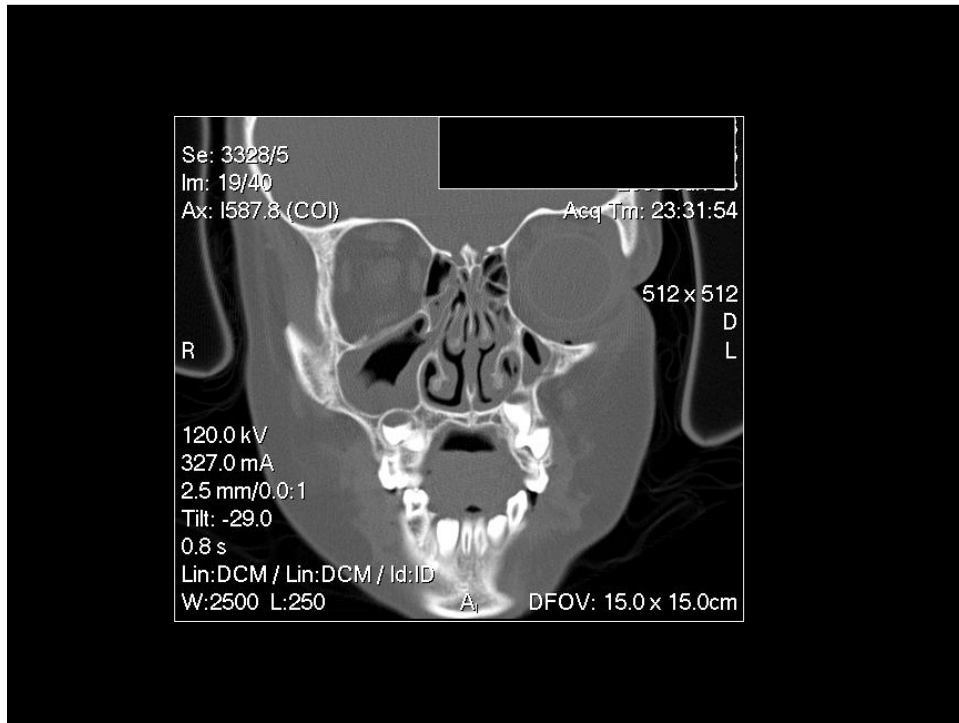


13

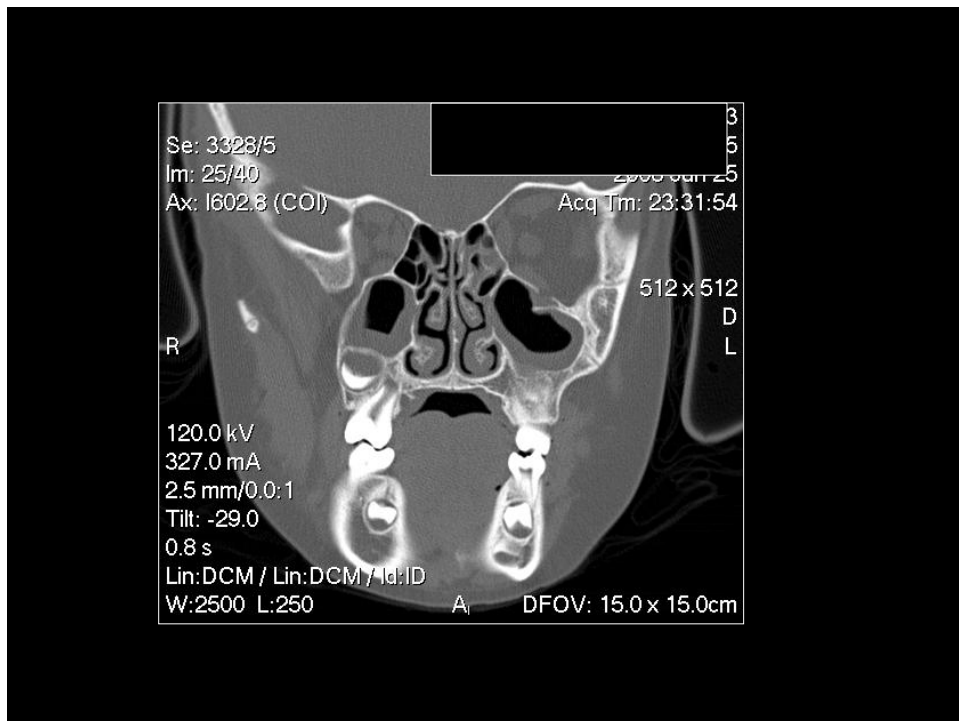
7 y/o White Male

- Hit in left eye with baseball bat
- + ecchymosis & sub conj hem
- No subjective diplopia or motility restriction
- Exoph = 17mm OU

14



15



16

27 y/o Arabic Male

- c/o vertical diplopia following blunt trauma
- Diplopia:
 - Near > Dist.
 - Alleviated on left head tilt

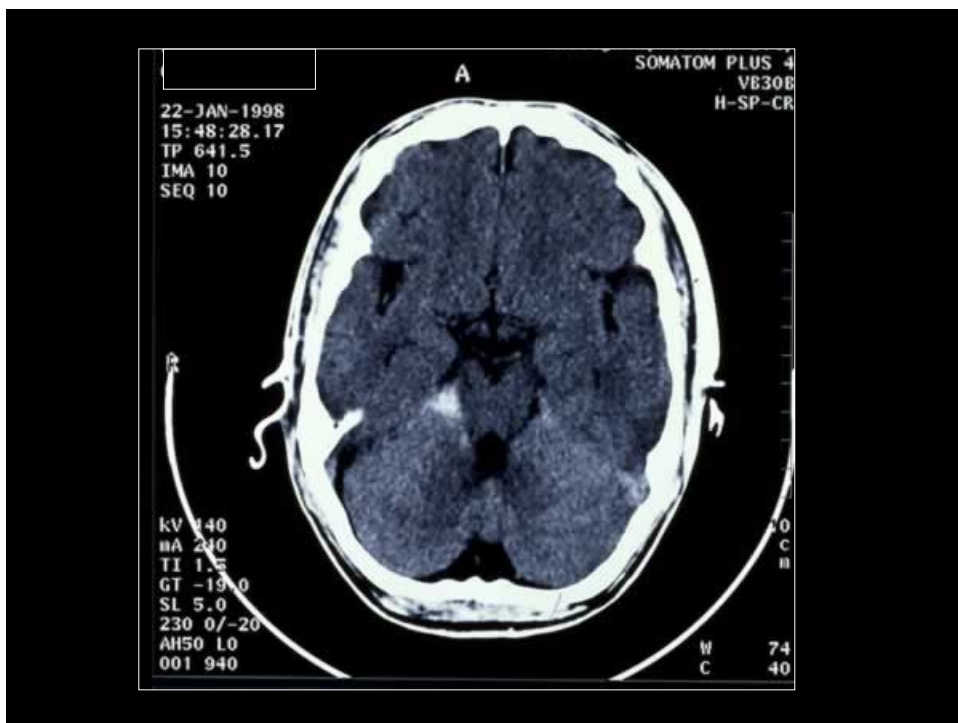
17



18



19



20

PROS & CONS OF CT

- CHEAP
- QUICK
- ADAPTABLE FOR ANGIOGRAPHY (CTA)
- *ACUTE BLOOD*
- *BONE DETAIL & ORBITS*
- SOFT TISSUE DIFFERENTIATION
- “BEAM-HARDENING” ARTIFACTS
- RESTRICTED IMAGING PLANES (AXIAL & CORONAL)
- IONIZING RADIATION



21

MAGNETIC RESONANCE IMAGING (MRI)

22

Background

- Px in strong magnetic field
- Alignment vector for hydrogen atoms (protons)
- Radiofrequency (RF) pulse
- Energy absorbed / released
- Released signal (“echo”) analyzed by receiver coils
- Computed image construction

23

MRI Sequencing

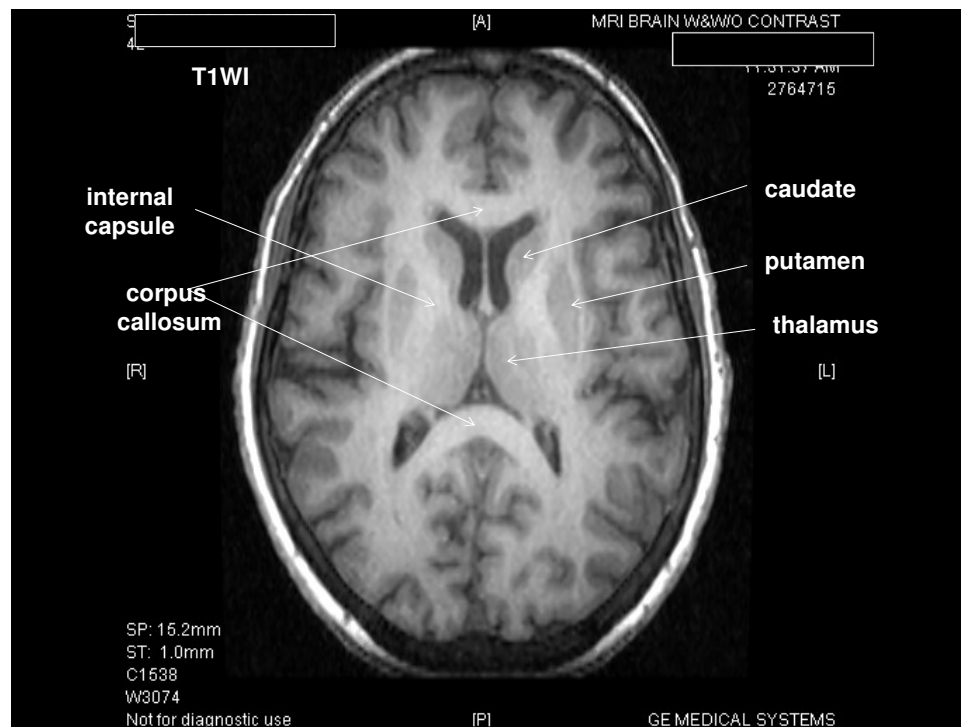
- T1-weighted
- T2-weighted
- Fluid attenuated inversion recovery (FLAIR)
- Fat suppression
- Diffusion-weighted imaging (DWI)

24

T1-Weighted Imaging

- Short TR (≤ 600 ms)
- Short TE (≤ 30 ms)
- Good resolution of anatomical detail
- Adaptable with contrast infusion

25



26

T2-Weighted Imaging

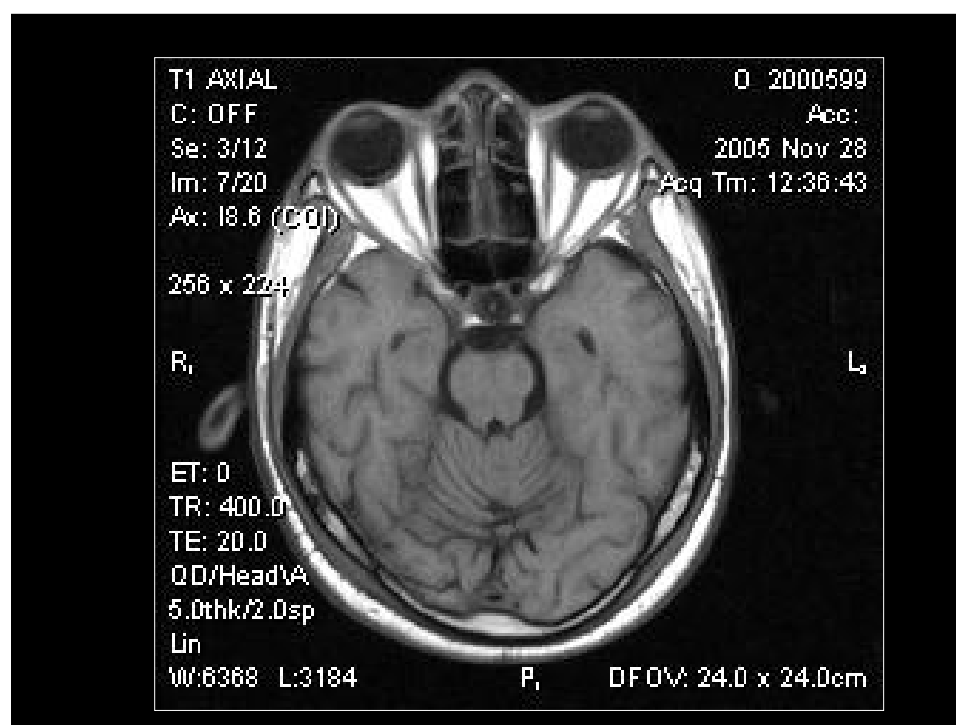
- Long TR (≥ 2000 ms)
- Long TE (≥ 80 ms)
- Good identification of pathology (fluid)
 - Edema
 - Demyelination
 - Infarction

27

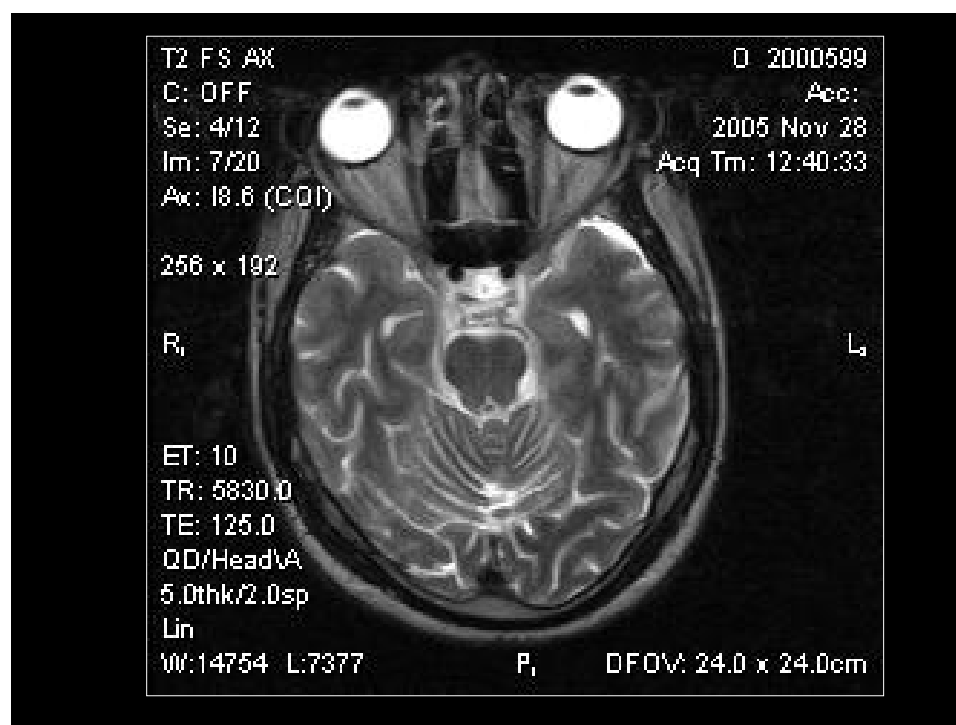
Signal Intensity (T-1 vs. T-2) Normal Brain

Structure	T-1 weighted	T-2 weighted
Brain (white/gray)	bright/ darker	dark/ brighter
CSF/H ₂ O	dark	bright
Vitreous/ aqueous	dark	bright
Fat	very bright	less bright
Rapid blood flow	black	black
Bone / air	black	black

28



29



30

56 y/o AA Male

- Clinical concern for right Horner syndrome
- Right-side facial anhidrosis & decreased tearing
- BVA:
 - 20/20 OD
 - 20/20 OS

31



Photo courtesy of Dr. Randi-Jo Francis

32



33

T-2
Likes
H₂O

34

66 y/o AA Male

- Long standing history of proptosis OD
- BVA:
 - LP OD (band keratopathy)
 - 20/20 OS

35



36

Signal Intensity (T-1 vs. T-2) Abnormal Tissue

Lesion	T-1 weighted	T-2 weighted
Infarct	Dark	Bright
Blood	Bright (early & late subacute)/ Dark (hyperacute & chronic)	Bright (hyperacute & late subacute) Dark (acute / early subacute & chronic)
Demyelinating plaques	Normal (acute) Dark (chronic "black hole")	Bright
Protein	Dark (low-very high%) Bright (mod.-high%)	Bright (low%) Dark (mod.-very high%)

37

37 y/o AA Male

- Hx of recent auto accident with whiplash injury
- Transient monocular blindness, OD
- Right side neck pain with intracranial noise

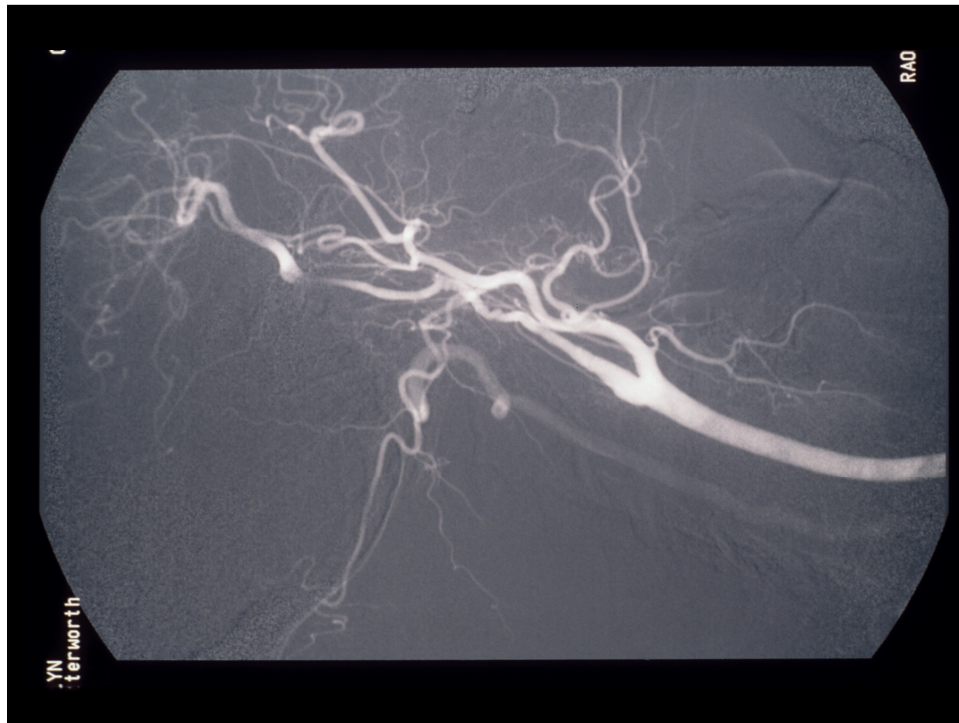
38



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40



41

Fluid Attenuated Inversion Recovery (FLAIR)

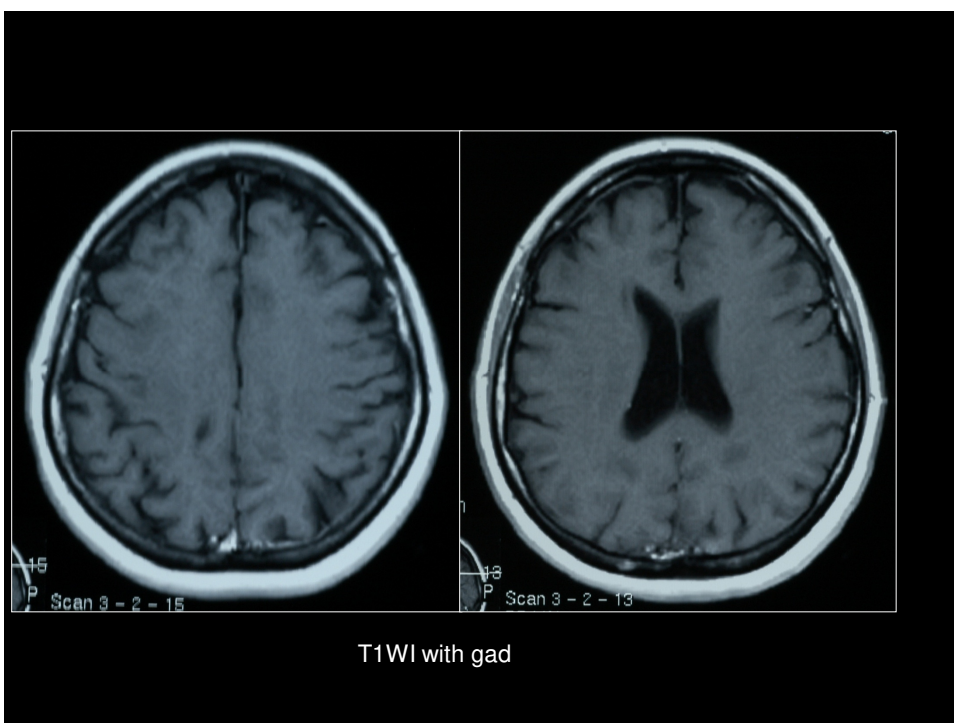
- T2WI with suppression of CSF signal
- Increased sensitivity for paraventricular lesions:
 - *Ischemic foci*
 - *Demyelinating plaques*

42

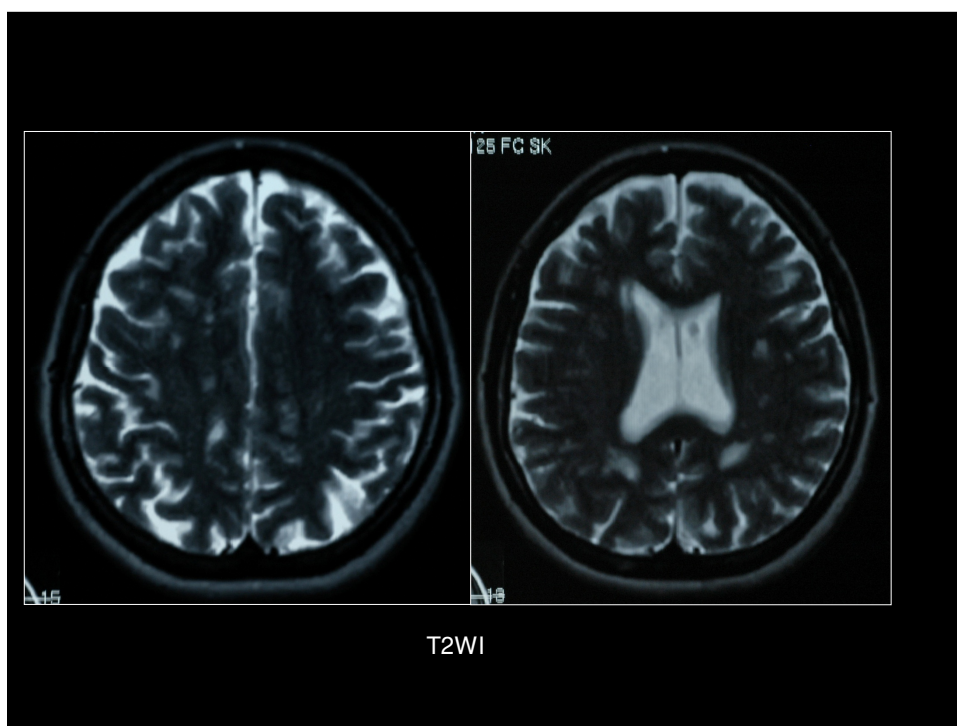
42 y/o Hispanic Female

- Previous bout of optic neuritis, OS
- H/o RR-MS

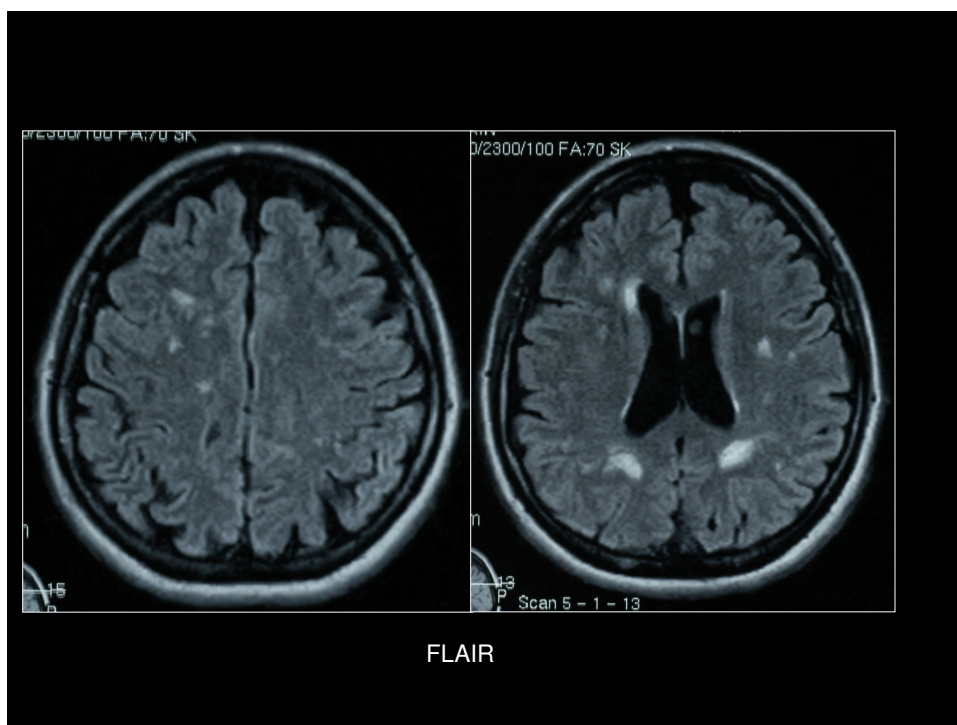
43



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46

Fat Suppression

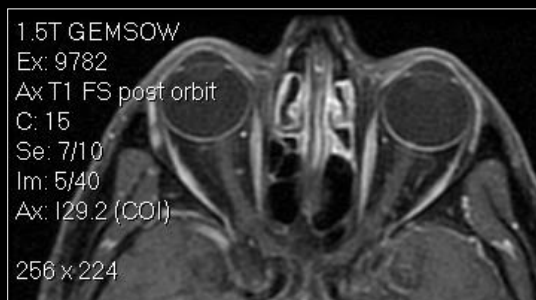
- Short tau inversion recovery (STIR)
- Fat saturation (FS)
 - **Orbits**
 - Neck
 - Bone marrow



56



T1 Axial

T1 Axial
FS post infusion

57

Paramagnetic Contrast Enhancement



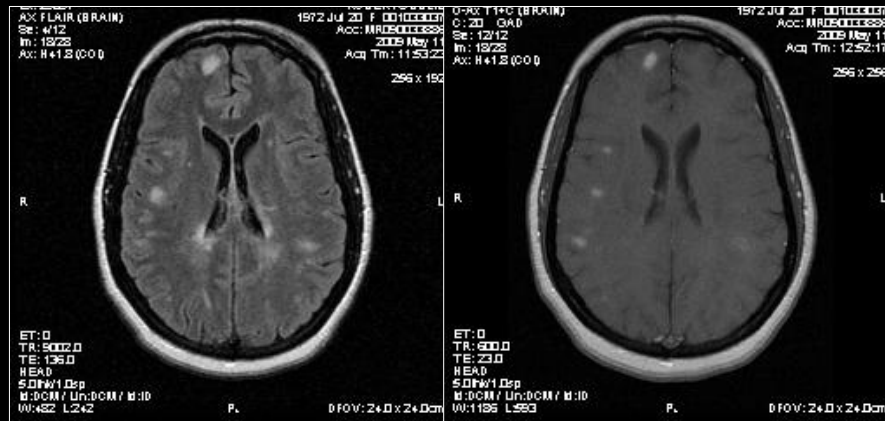
- Gadolinium (Gd-DTPA)
- Breakdown of blood-brain barrier
 - Edema
 - Vascularization
- Hyperintensity on T1 (shortens T1 signal)

58



59

42 y/o Female with optic neuritis



FLAIR

T1 Post Gad

60

58 y/o AA Male

- Progressive vision loss and proptosis, OD
- 6-month history of progressive pulmonary dysfunction
- BVA:
 - 20/80 OD (+ RAPD)
 - 20/20 OS

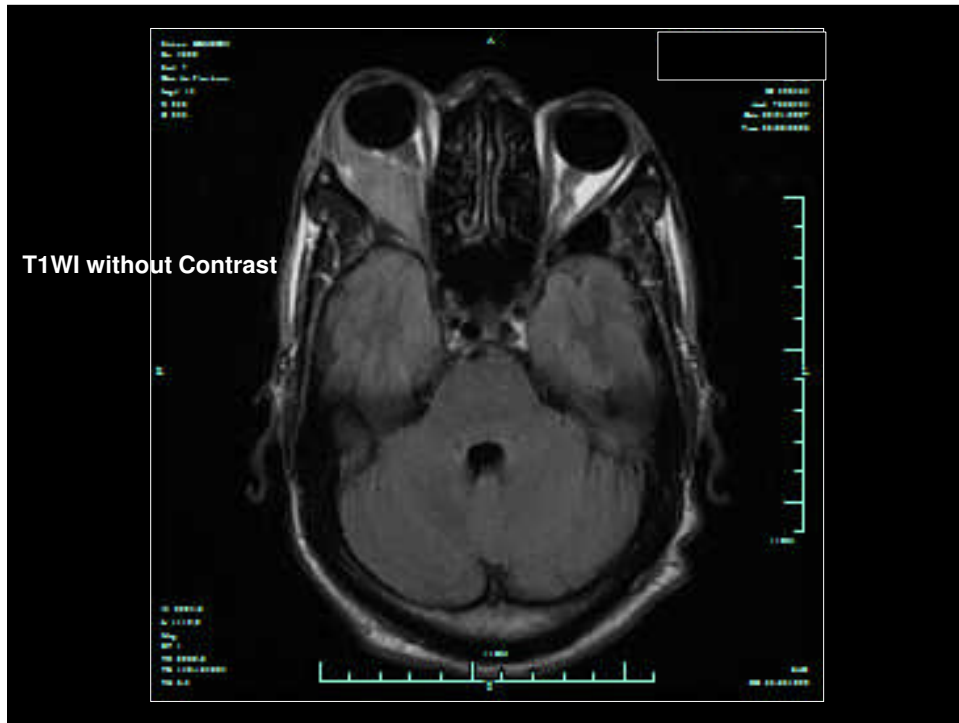
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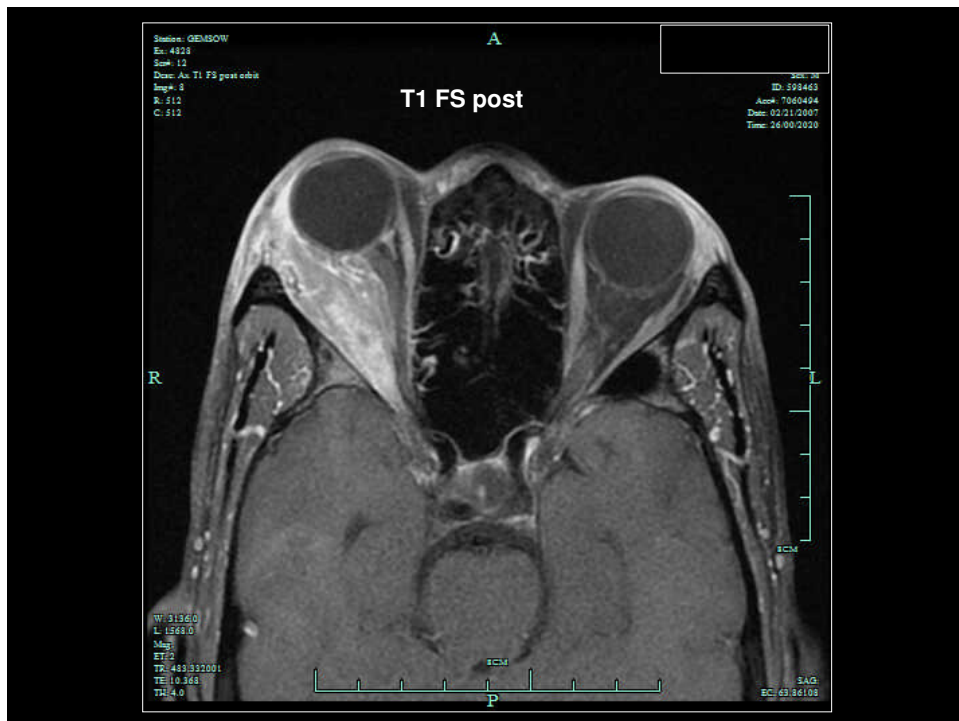
62



63



64

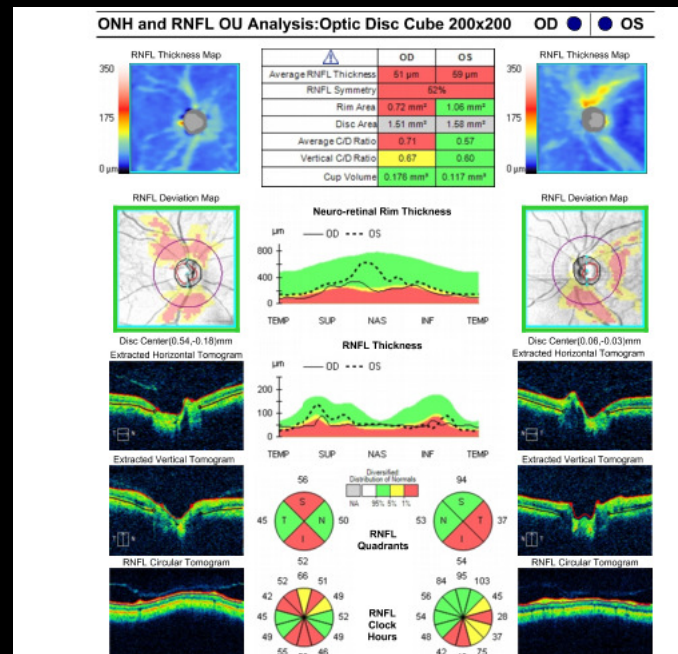


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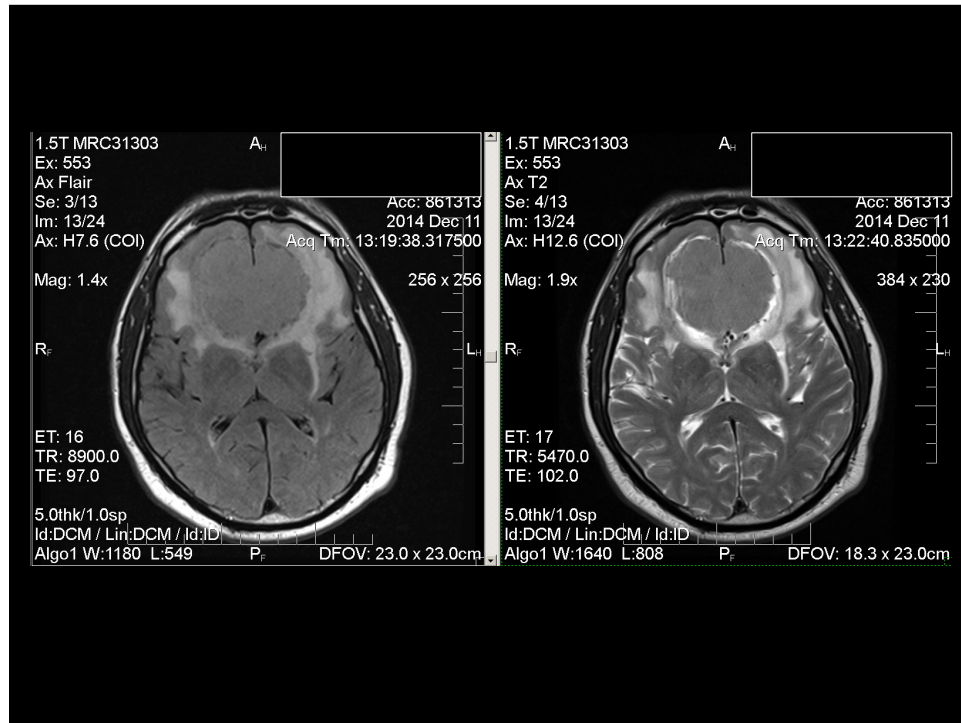
71 y/o AA Male

- Progressive vision loss OD > OS (months to years?)
- BVA:
 - LP OD
 - 20/60 OS

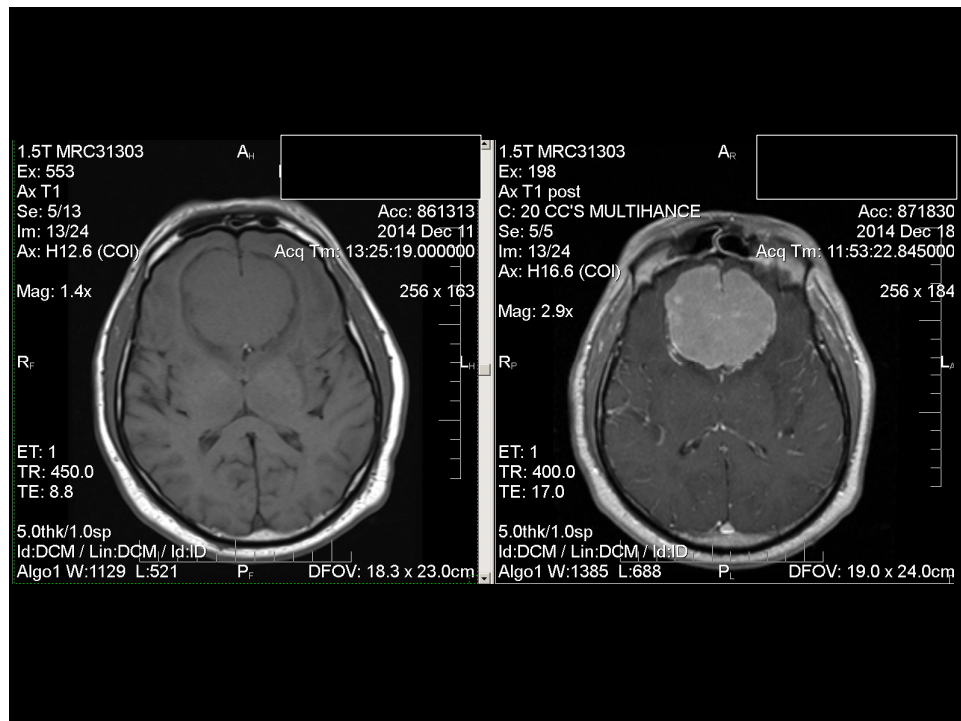
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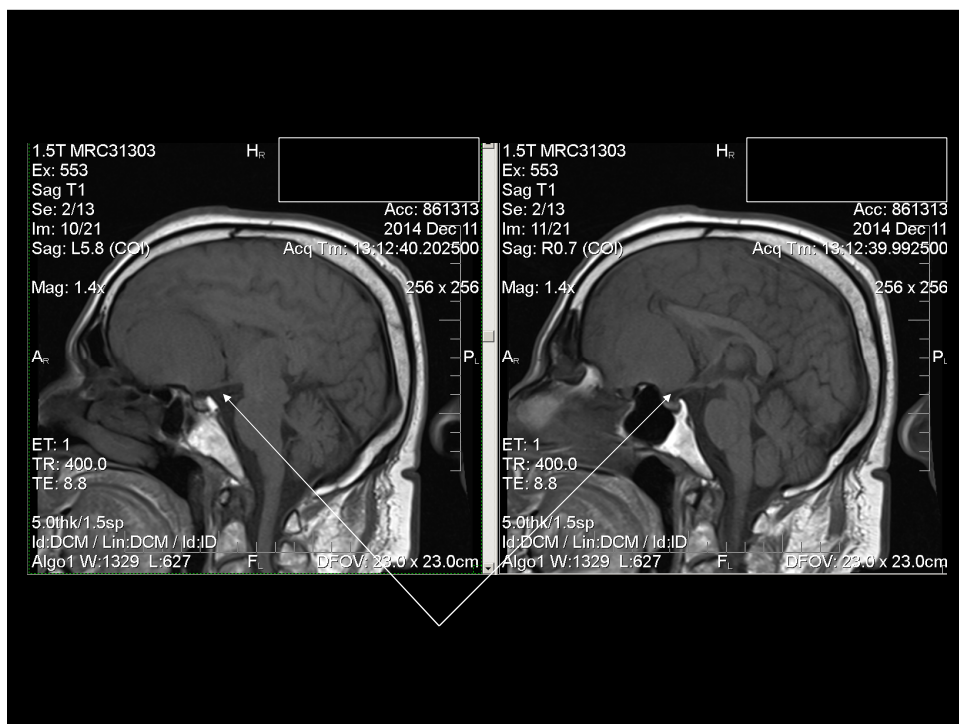
67



68



69



70



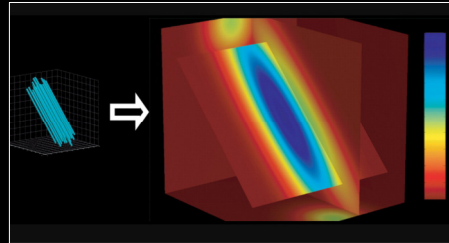
*One thing you should never do is drink
a few glasses of Ciroc vodka at an open
bar event and then have a glass of
straight Hennessy afterwards on a
school night.*

Mondayramble.com

76

Diffusion-Weighted Imaging

- Variant of T2WI
- Assessment of the ability of water molecules to freely move (diffuse) within biological tissue ("Brownian motion")
- Within white matter, water molecules show a linear diffusion parallel to axonal fibers



Hagman P, et al. *RSNA* 2006

77

DWI (cont.)

- Acute stroke → translocation of water from the extracellular to the intracellular compartment, where water mobility is relatively **more restricted** (cytotoxic edema)
- Restricted diffusion = hyperintensity on DWI

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DWI (cont.)

- Immediate detection of cerebral ischemia
 - Increased signal intensity within minutes
 - maximal signal intensity within 2-4 days
 - Slow return to baseline

79

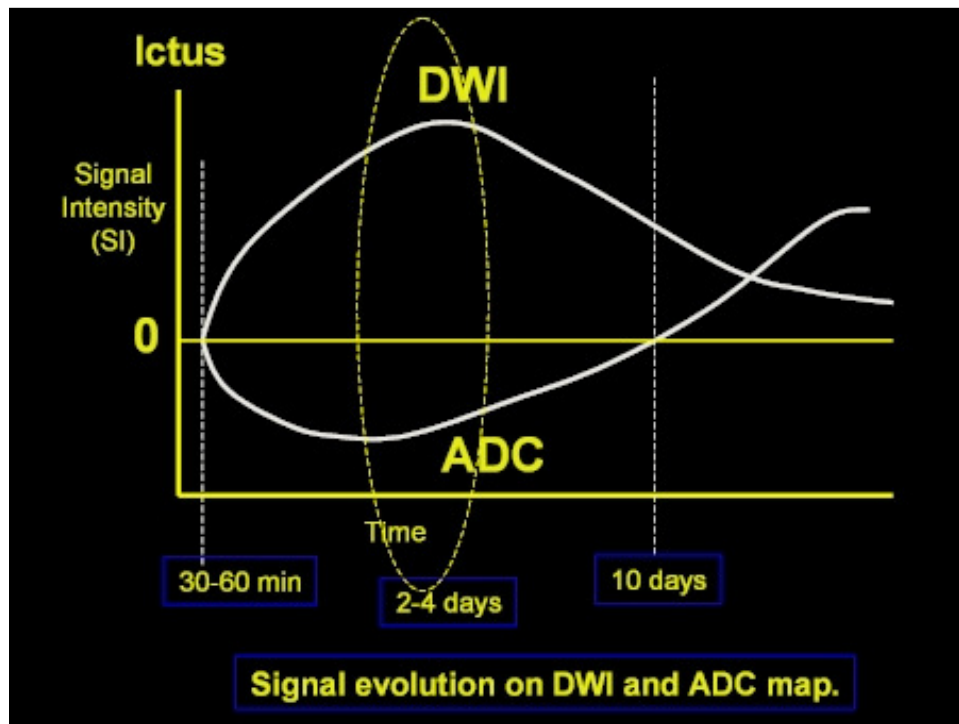
Apparent Diffusion Coefficient “ADC Map”

- Chronicity of stroke:
 - Acute infarct (cytotoxic edema) = low ADC
 - Subacute/chronic infarct (vasogenic edema) = high ADC



“T2 Shine Through”

80

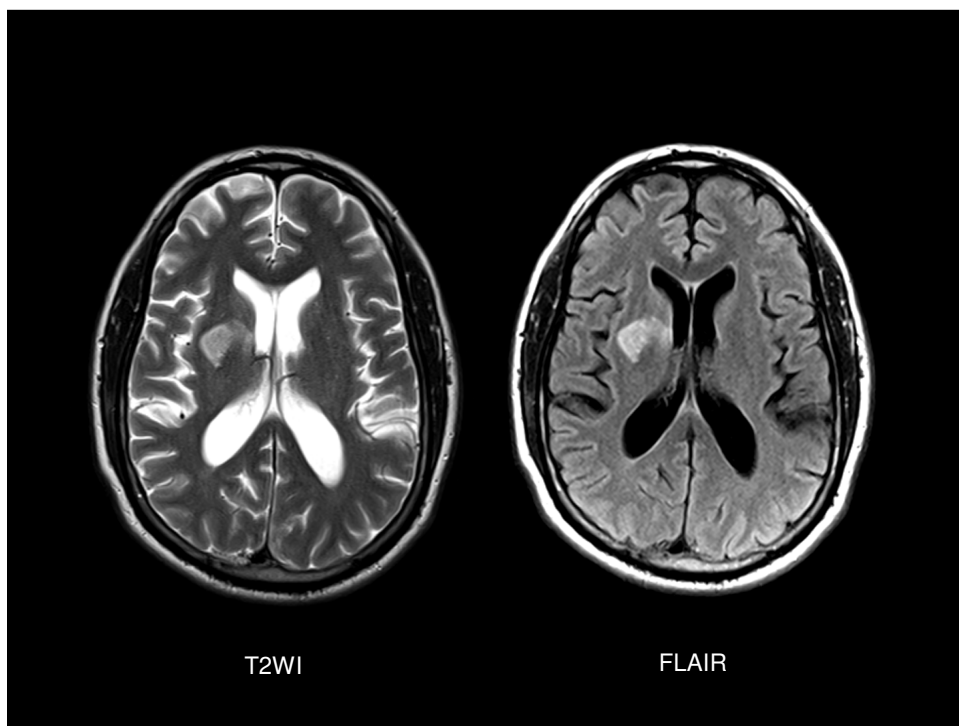


81

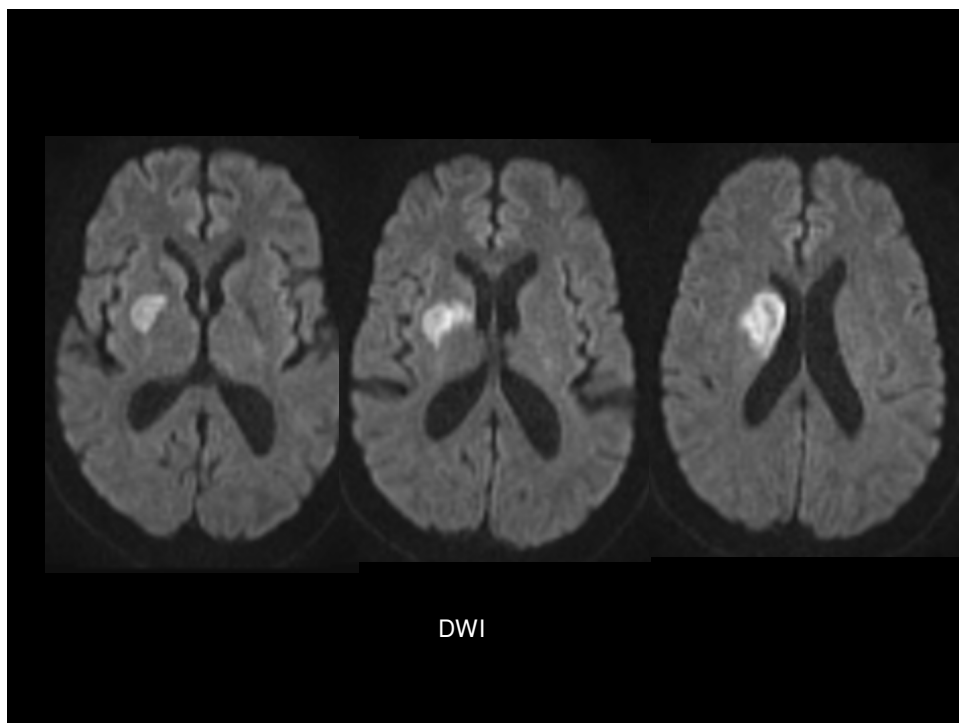
46 y/o Hispanic Male

- Evaluation of optic atrophy OU
- H/o diabetes and hypertension
- BVO:
 - 20/20 OD
 - 20/20 OS
- Recent-onset tremor, confusion, depression, lower left facial weakness and eye tracking problems (impaired saccades greater looking to left)

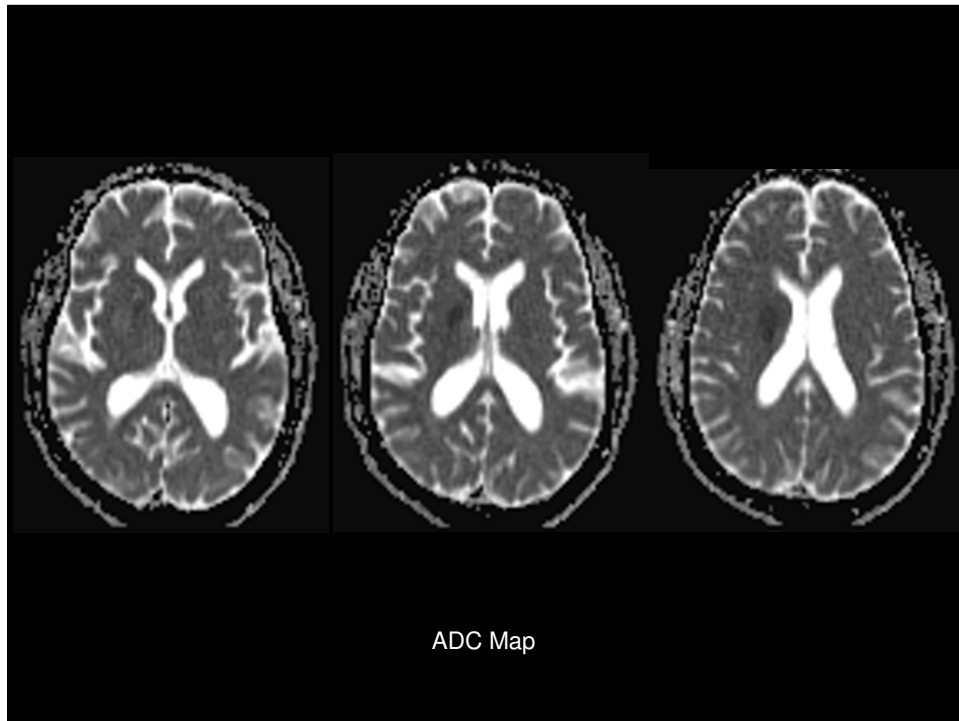
82



83



84



85

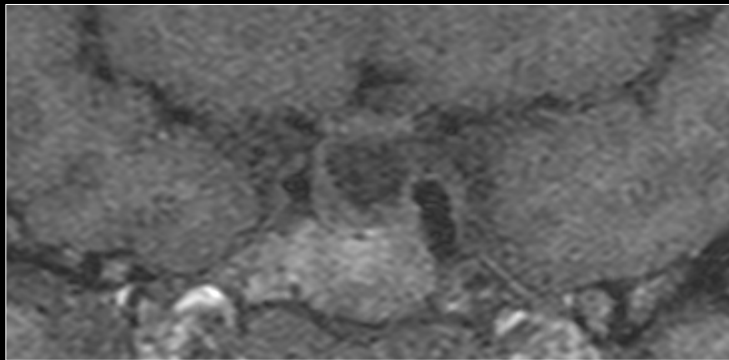
PROS & CONS OF MRI

- | | |
|-------------------------------|----------------------------------|
| • SOFT TISSUE | • \$\$\$ |
| • POSTERIOR FOSSA | • LONGER TIME |
| • SAGITAL PLANE | • CONTRAINDICATED |
| • DEMYELINATION / MS | • WITH METAL, |
| • CHRONICITY OF STROKE | • PREGNANCY & OBESITY |



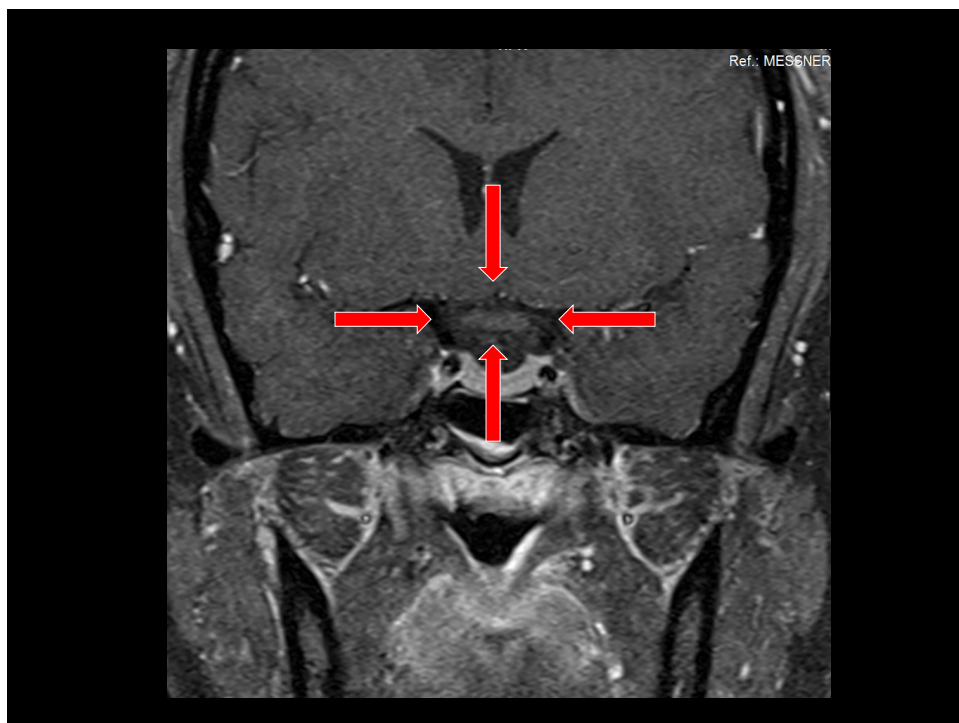
90

“The chiasm lives in a rough neighborhood.”



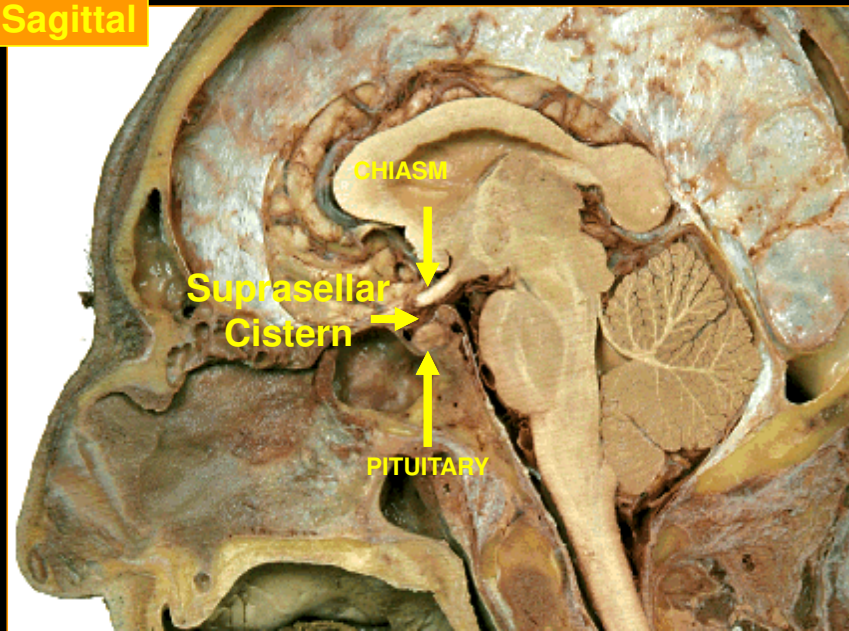
Lawrence G. Gray, OD

91

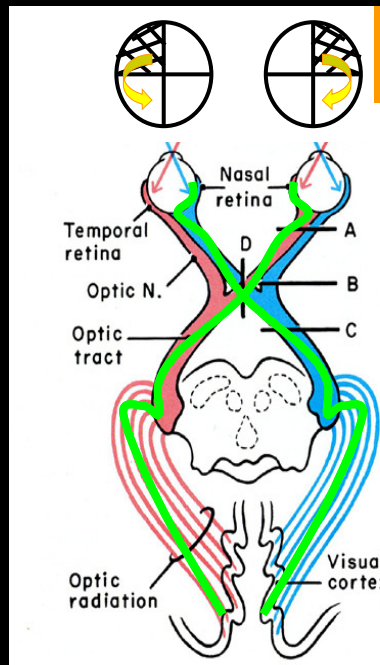


92

Sagittal



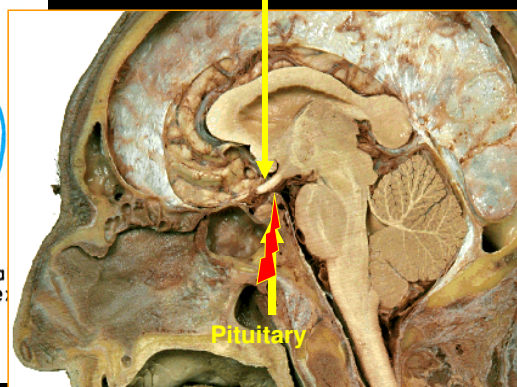
93



Visual field loss

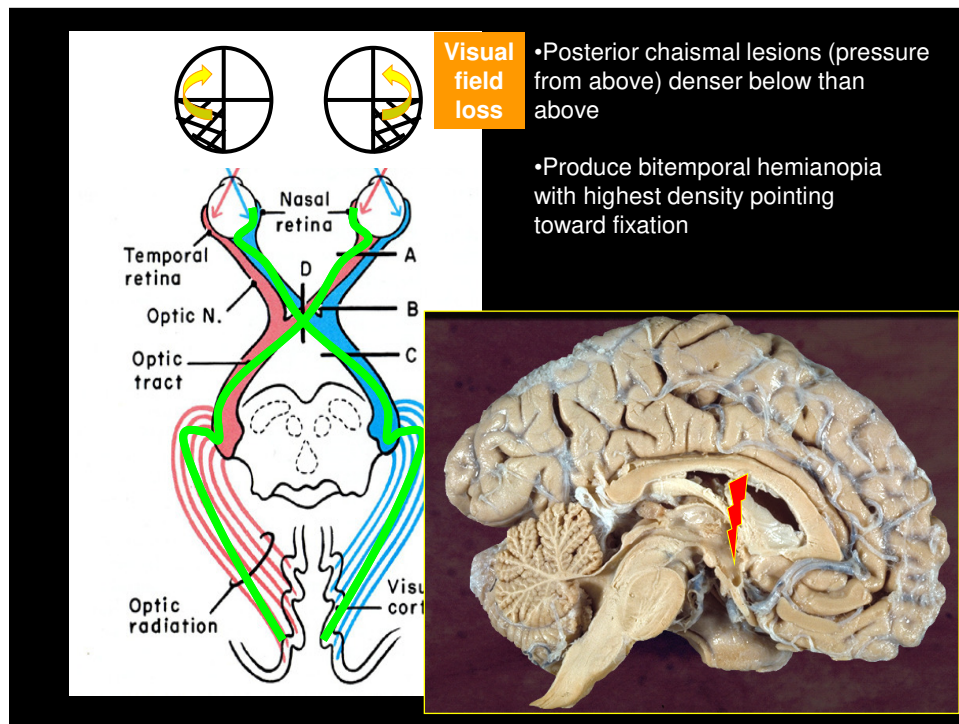
- Bitemporal hemianopia
- Denser above than below
- Progression to entire hemifield
- Classic for pituitary adenoma

Chiasm



Pituitary

94

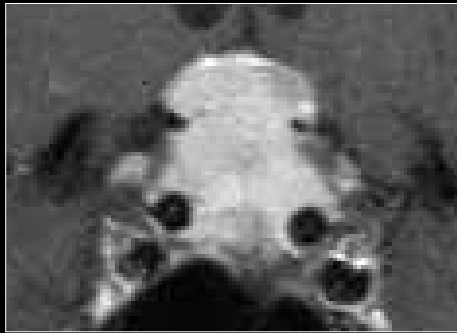


95

Lesions of the Chiasm

97

Pituitary Adenomas



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Pituitary Adenoma

- Benign tumors of pituitary origin
- Third most common intracranial tumor (25% prevalence at autopsy/MRI)
- Micro vs. macroadenoma (>10mm)
- Secretory (prolactin) vs. non-secretory
- Localized (2/3) vs. invasive (1/3)
- Do not produce papilledema

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Pituitary Adenoma (cont.)

- MRI findings:
 - Iso-intense to brain
 - homogeneous staining with gadolinium (highly vascularized)

109

Pituitary Adenoma (cont.)

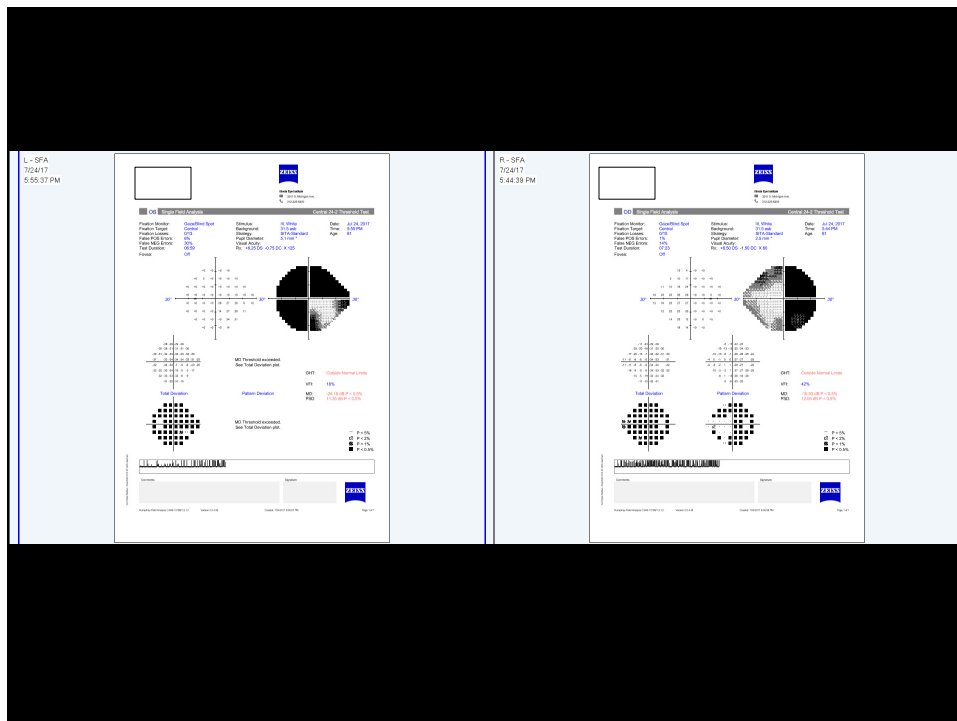
- Complications:
 - Endocrine dysfunction
 - Pituitary apoplexy
 - Vision!!

110

61 Y/O Hispanic Woman

- C/o progressive vision loss, both eyes
- Approx. 2 years duration
- BVA:
 - 20/40 OD
 - 20/70 OS

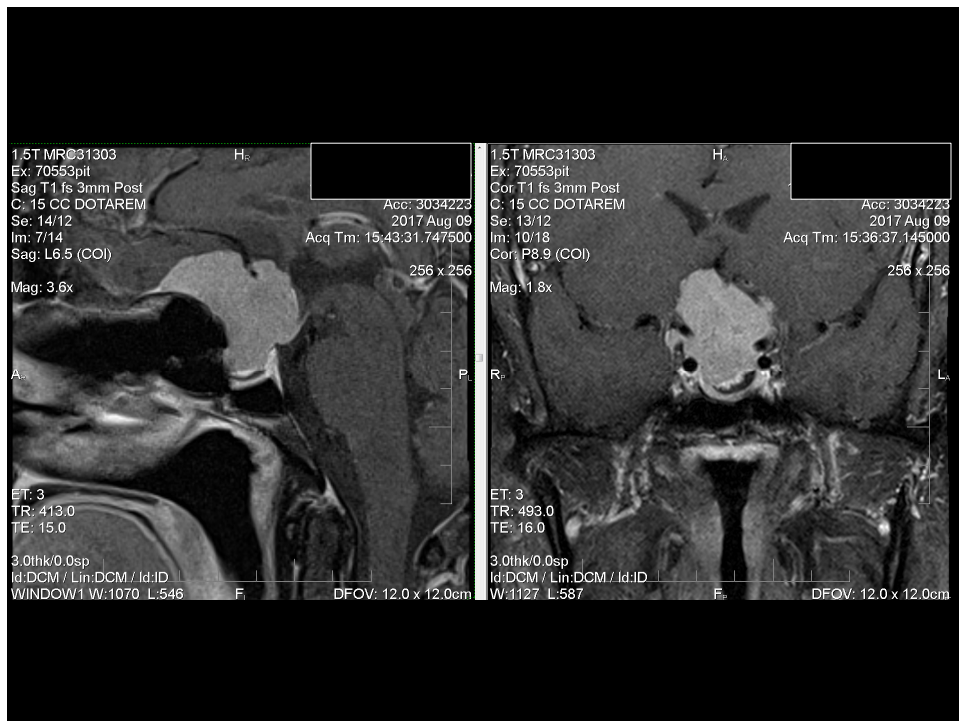
111



112



113



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Optical coherence tomography retinal ganglion cell complex analysis for the detection of early chiasmal compression

Richard J. Blanch^{1,2,3} · Jonathan A. Miceli¹ · Nelson M. Oyesiku⁴ · Nancy J. Newman^{1,4,5} · Valérie Biousse^{1,5}

Published online: 10 August 2018
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Abstract

Purpose To report patients with sellar tumors and chiasmal compression with normal visual fields, who demonstrate damage to the retinal nerve fiber layer (RNFL) and ganglion cell complex (GCC) on optical coherence tomography (OCT).

Methods Seven patients with sellar tumors causing mass effect on the optic chiasm without definite visual field defect, but abnormal GCC are described. GCC/RNFL analyses using Cirrus-OCT were classified into centiles based on the manufacturer's reference range.

Results In seven patients with radiologic compression of the chiasm by a sellar tumor, OCT-GCC thickness detected compressive chiasmopathy before visual defects became apparent on standard automated visual field testing. Without OCT, our patients would have been labelled as having normal visual function and no evidence of compressive chiasmopathy. With only OCT-RNFL analysis, 3/7 patients would still have been labelled as having no compression of the anterior visual pathways.

Conclusions These patients show that OCT-GCC analysis is more sensitive than visual field testing with standard automated perimetry in the detection of compressive chiasmopathy or optic neuropathy. These cases and previous studies suggest that OCT-GCC analysis may be used in addition to visual field testing to evaluate patients with lesions compressing the chiasm.

Keywords Pituitary adenoma · Sellar mass · Chiasmal compression · Optic neuropathy · Visual field test · Optical coherence tomography · Ganglion cell complex analysis

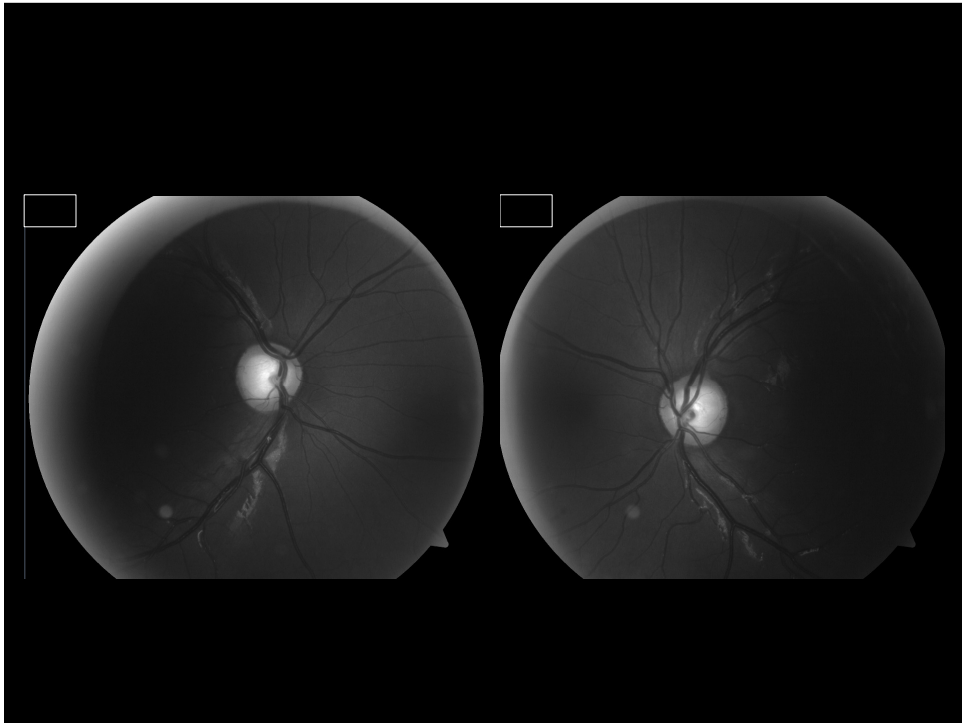
Blanch RJ, et al. *Pituitary* 2018

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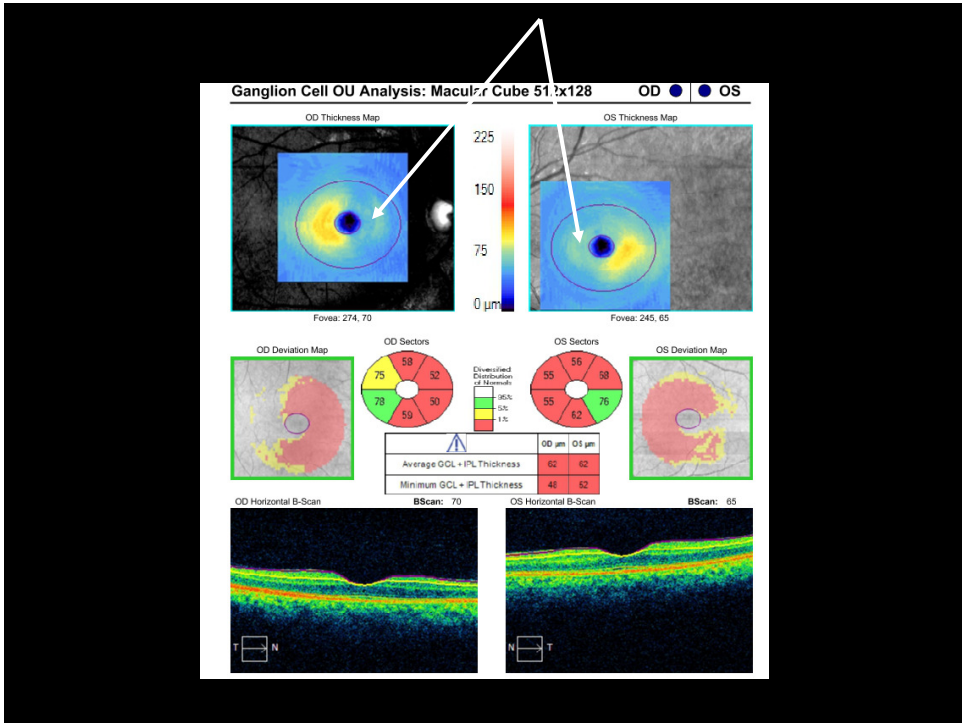
18 Y/O AA Man

- C/o vision loss OS 1-2 years ago
- Vision OD is “perfect”
- BVA:
 - 20/20 OD
 - 20/500 OS

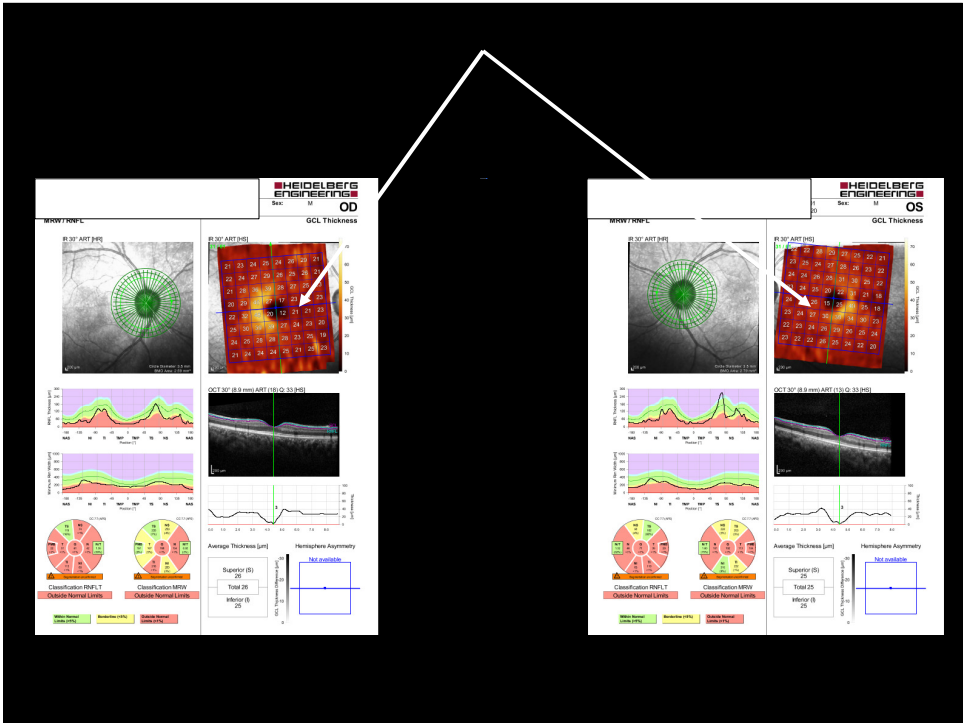
122



123



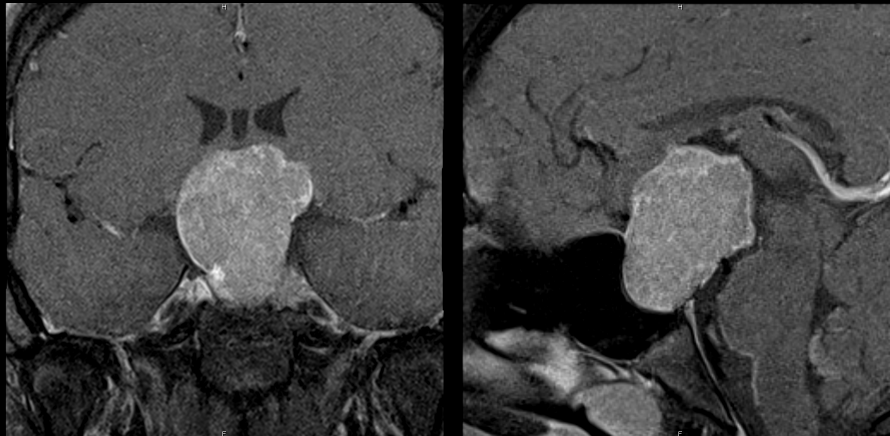
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127

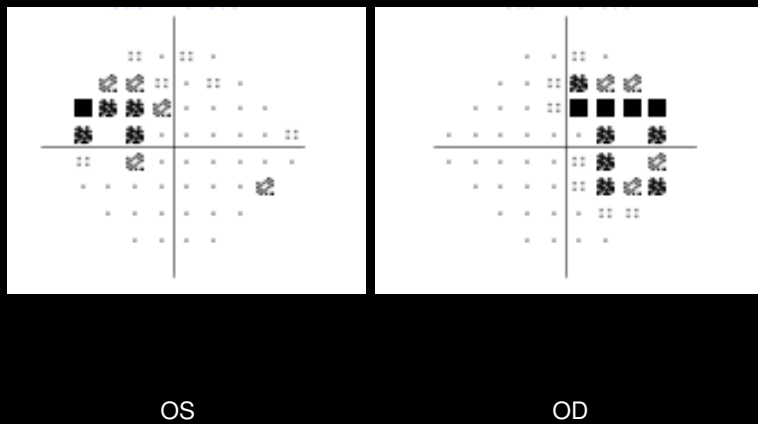
**Not all bitemporal defects are due
to chiasmal disease...**

128

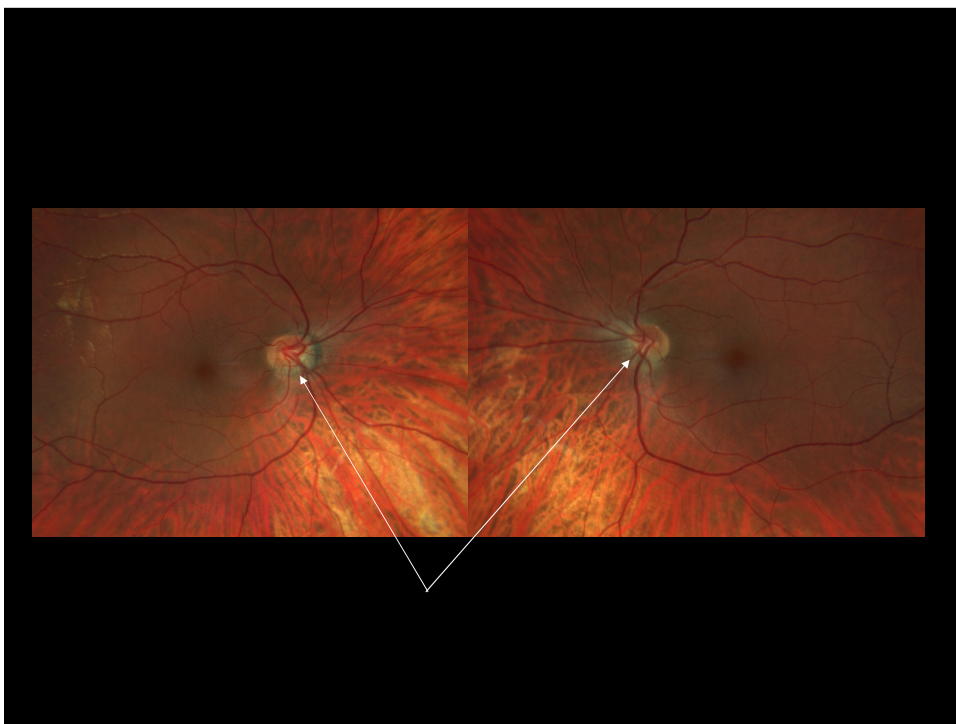
27 Y/O Caucasian Man

- Suspicion of chiasmal compression
- Moderate-high myopia
- BVA:
 - 20/20 OD
 - 20/20 OS

129



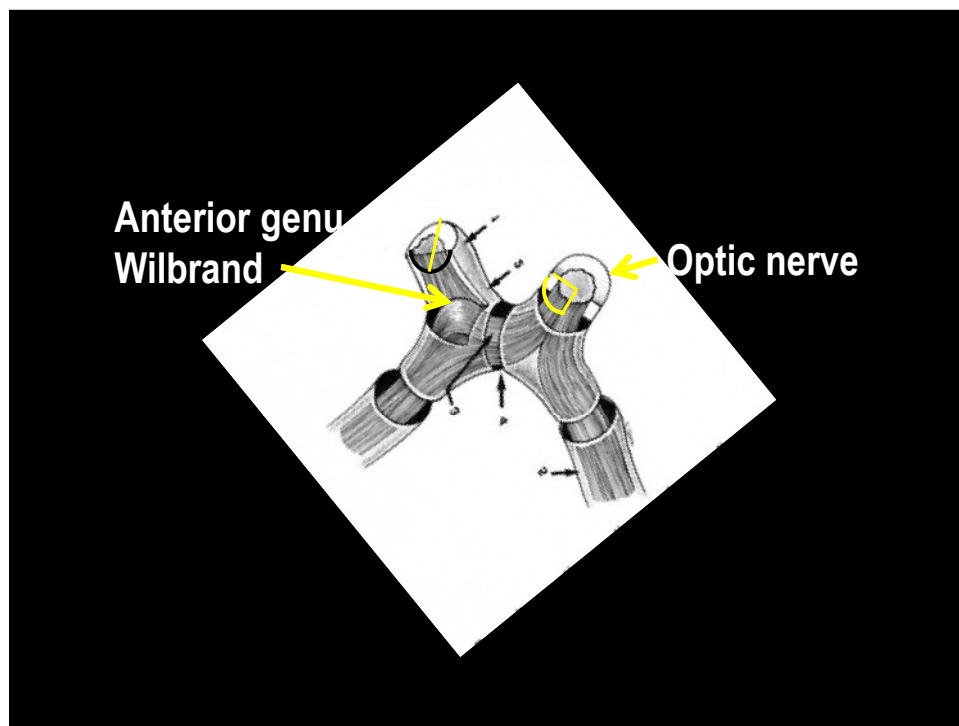
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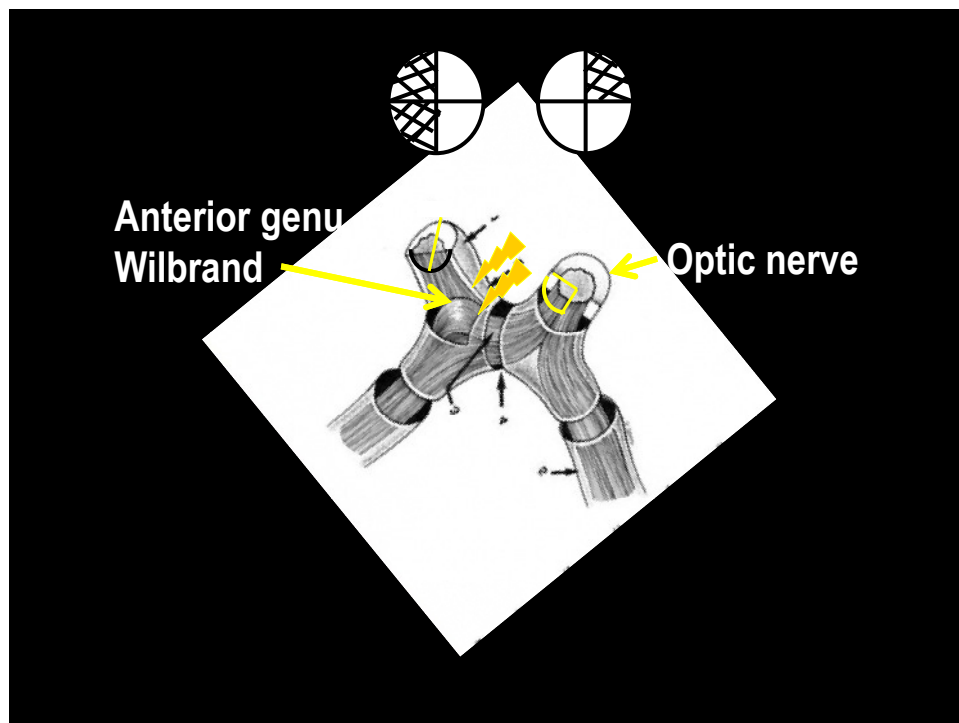
131

Anterior Chiasmal Syndrome

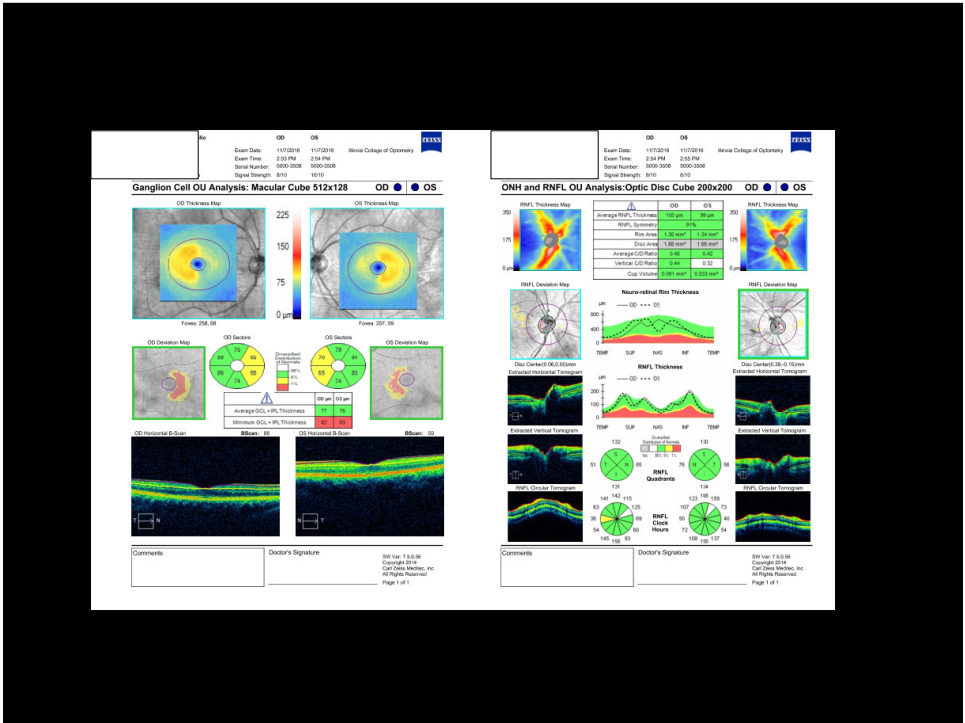
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133



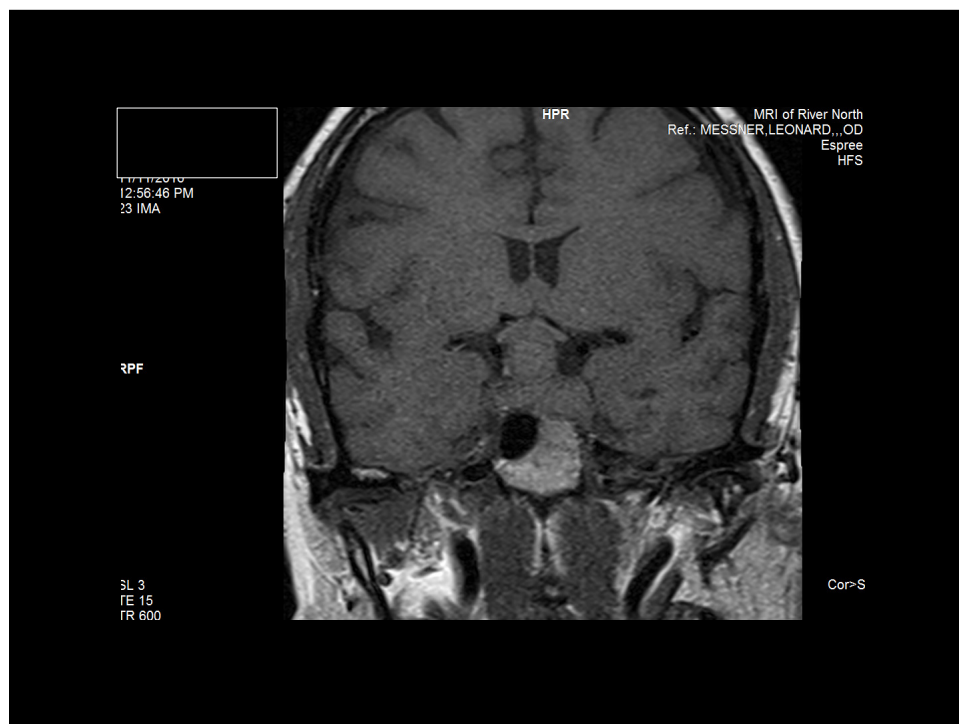
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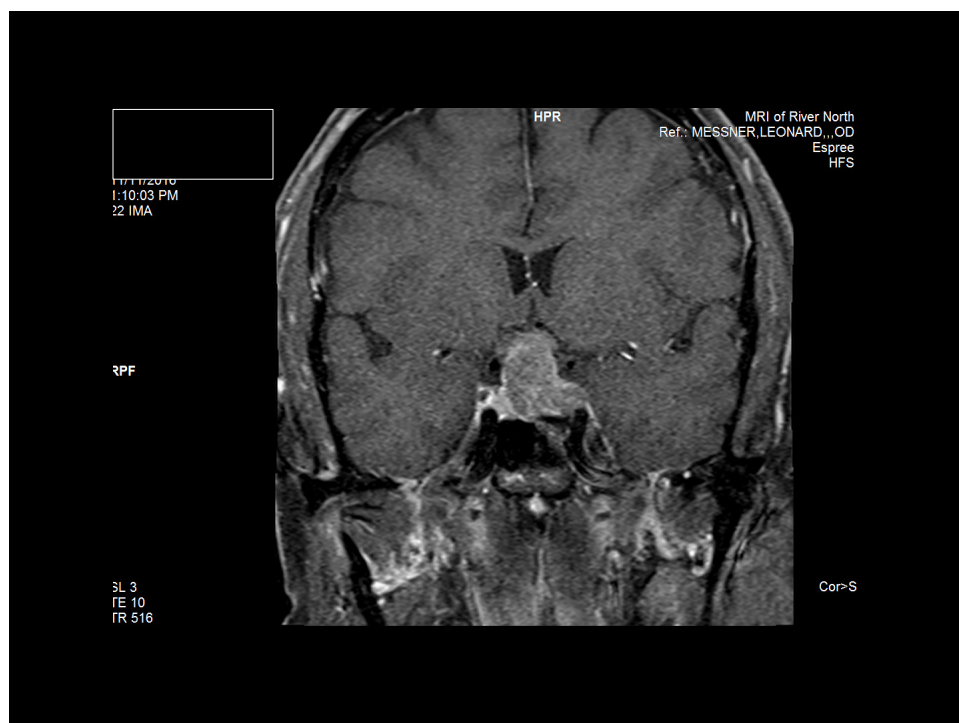
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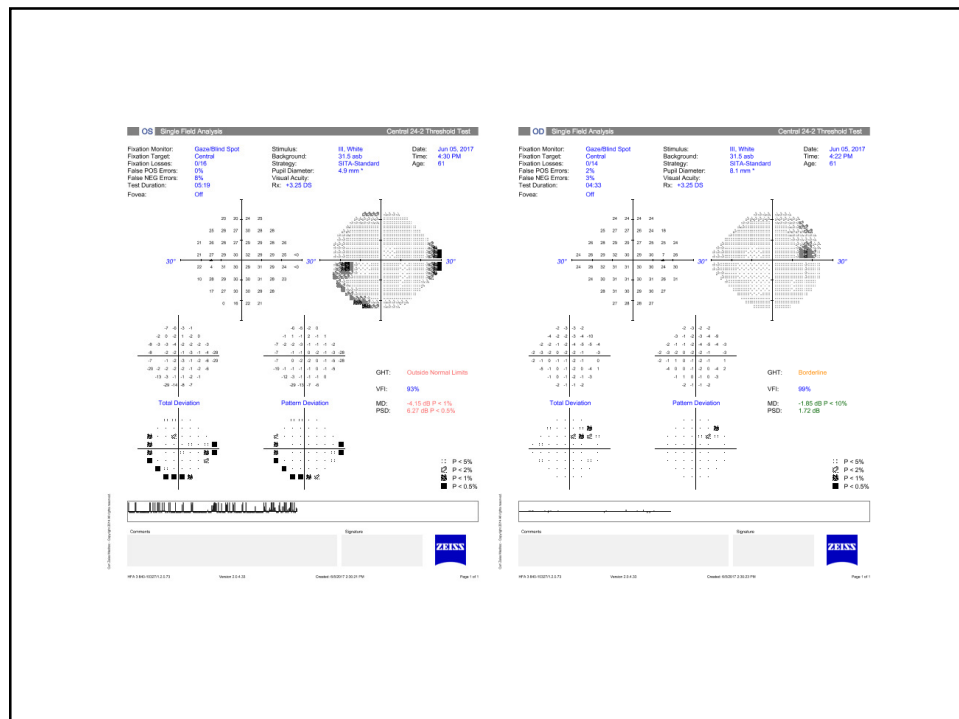


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S/P Trans-sphenoidal Resection of Tumor

- BVA:
 - 20/20 OD
 - 20/20 OS

141

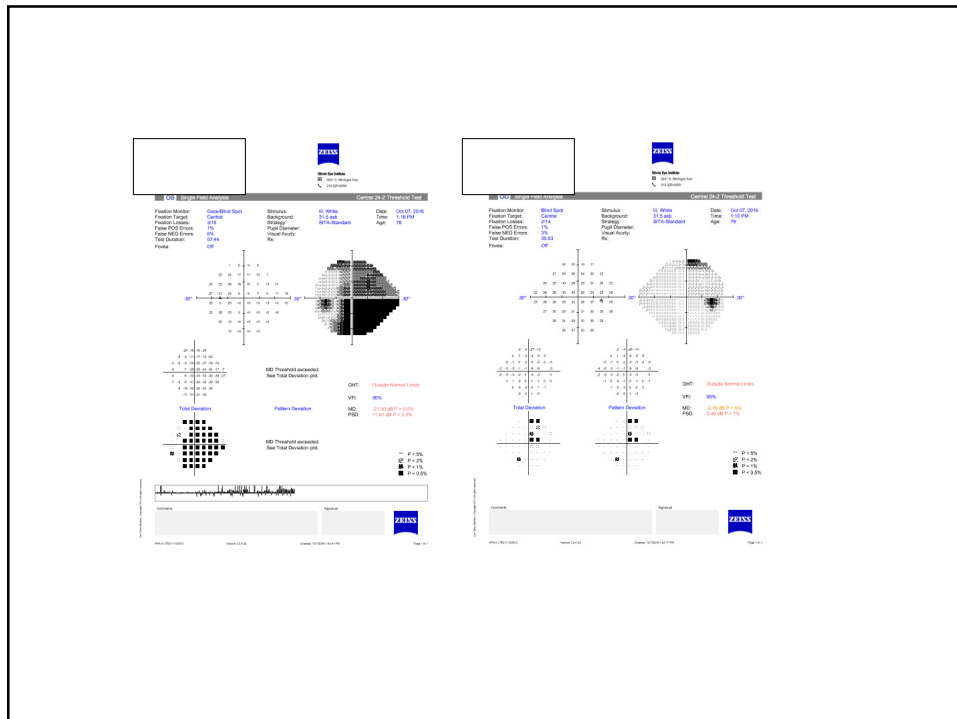


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79 y/o AA Man

- C/o progressive vision loss OS x several years
- BVA:
 - 20/20 OD
 - 20/60 OS

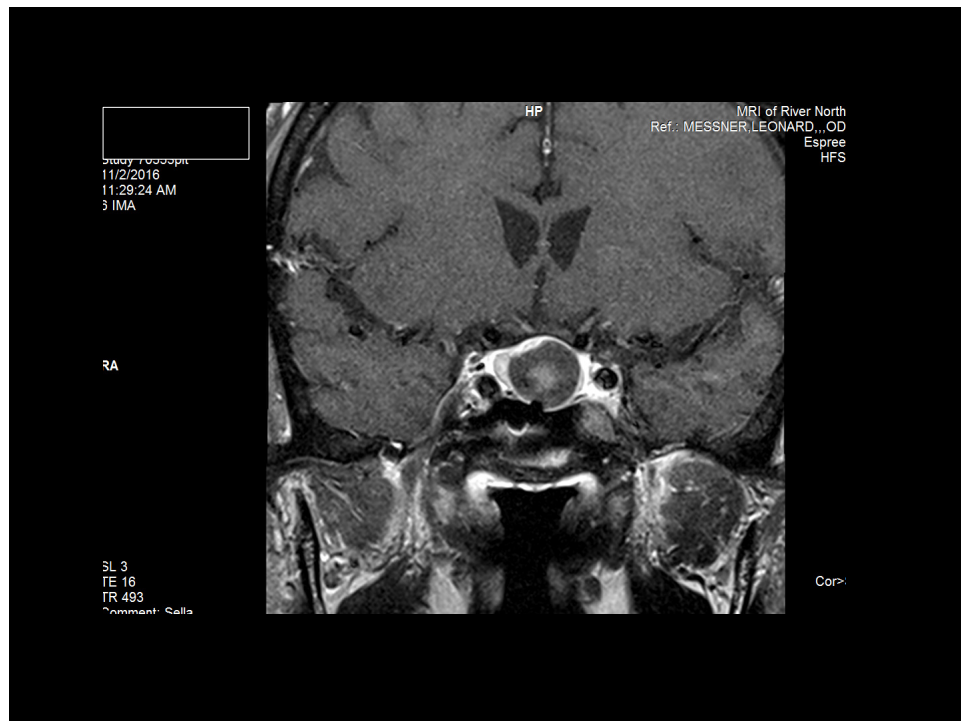
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Rathke's Cleft Cyst

- Benign, cystic tumors from embryonic remnant of Rathke pouch (33% of autopsy specimens)
- Often with mucin-derived nodule (iso/hyperintense to brain)
- Trans-sphenoidal drainage vs. extirpation
- Variable recurrence

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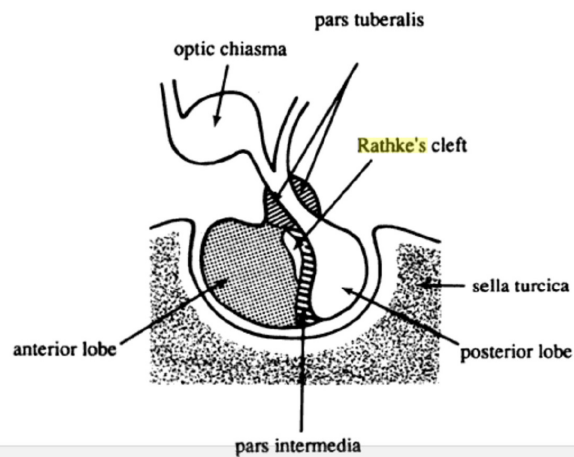


Fig. 2: A diagram to show the location of Rathke's cleft which can give rise to Rathke's cleft cyst.

© Surgical Pathology of the Head and Neck, Volume 3 By Leon Barnes

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Invasive Pituitary Adenomas

- 35% of all pituitary adenomas
- Invasion of parasellar regions:
 - Vascular (cavernous sinus)
 - Neural tissues
 - Bone
- Rapid growth/early recurrence (within 6 months of removal)

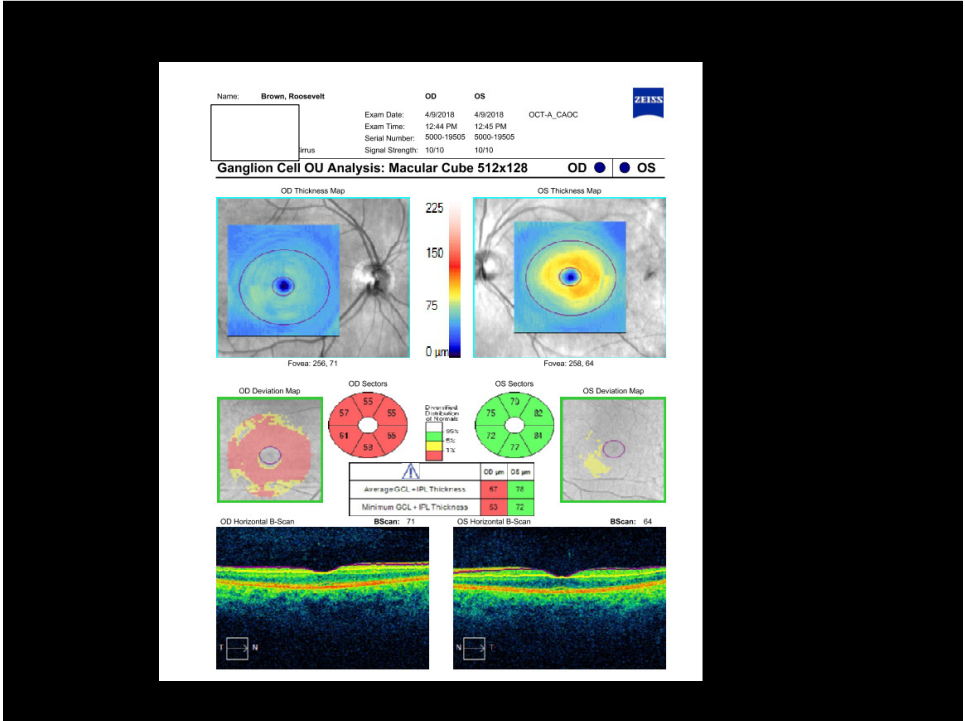
Moldovan IA, et al. *Romanian Neurosurg* 2016

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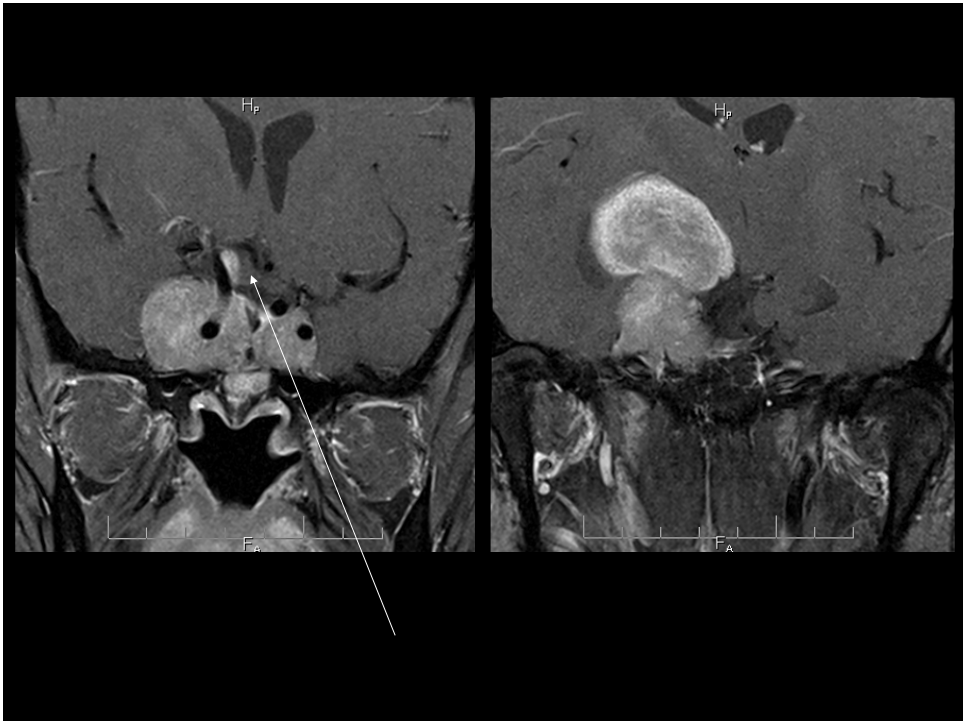
44 y/o AA Man

- Progressive vision loss OD x 4 years
- s/p trans-sphenoidal resection of “pituitary mass” in 2014
- BVA:
 - HM OD
 - 20/30 OS

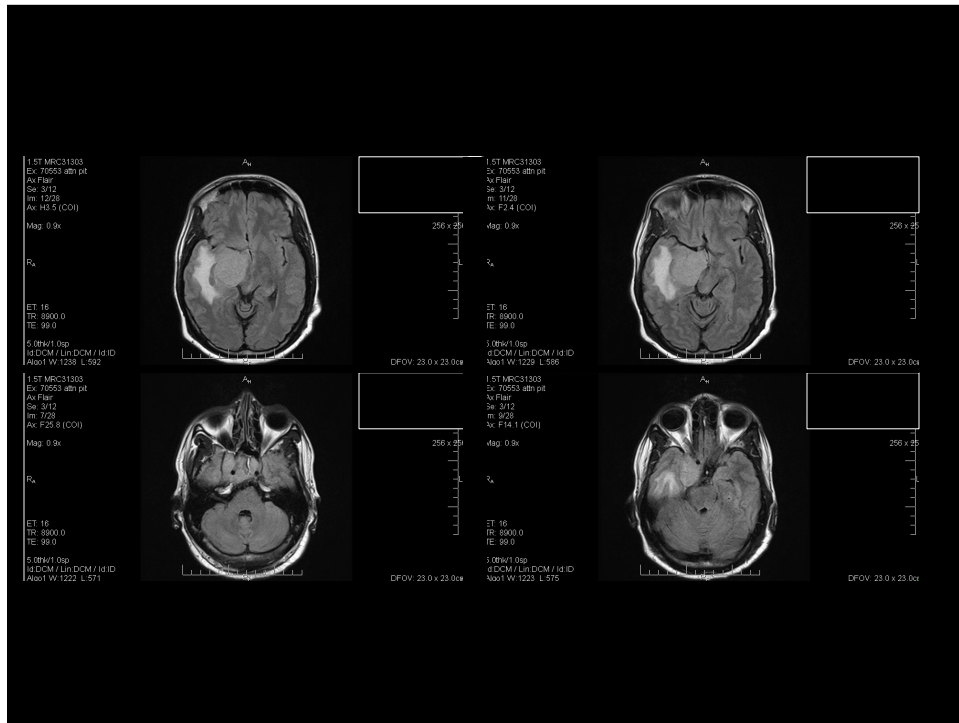
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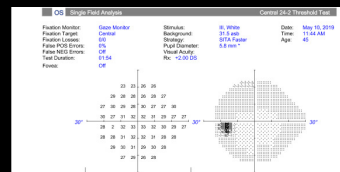
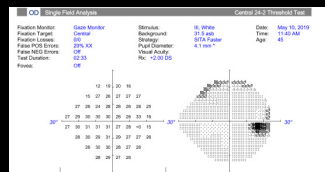
152



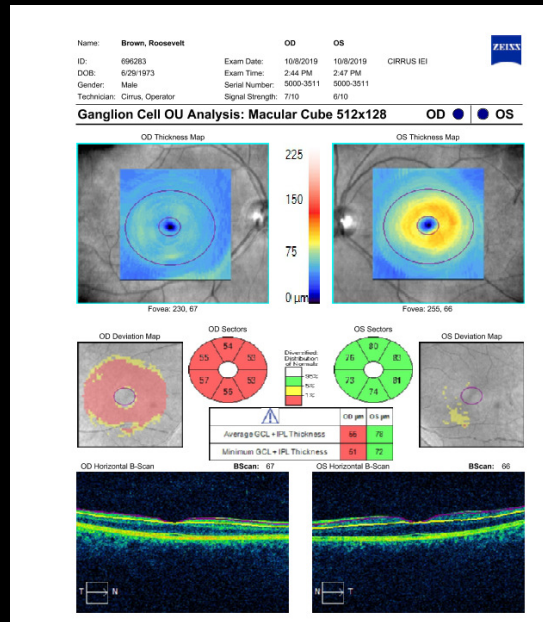
153

3 months s/p surgical resection of tumor

- BVA:
 - 20/25 OD
 - 20/20 OS



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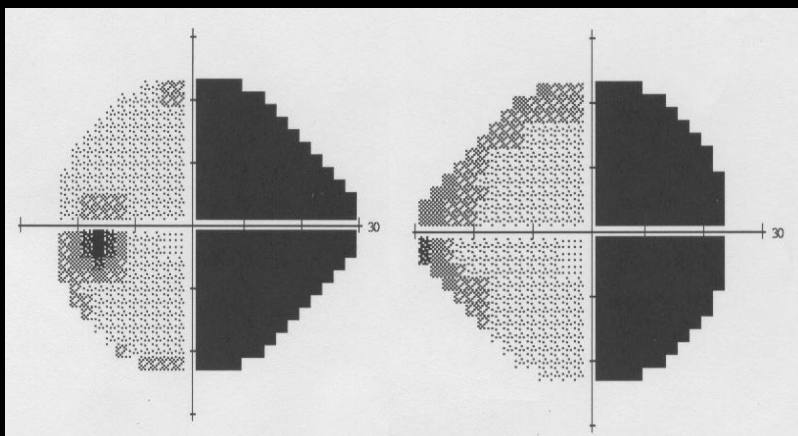
Retro-chiasmal Lesions

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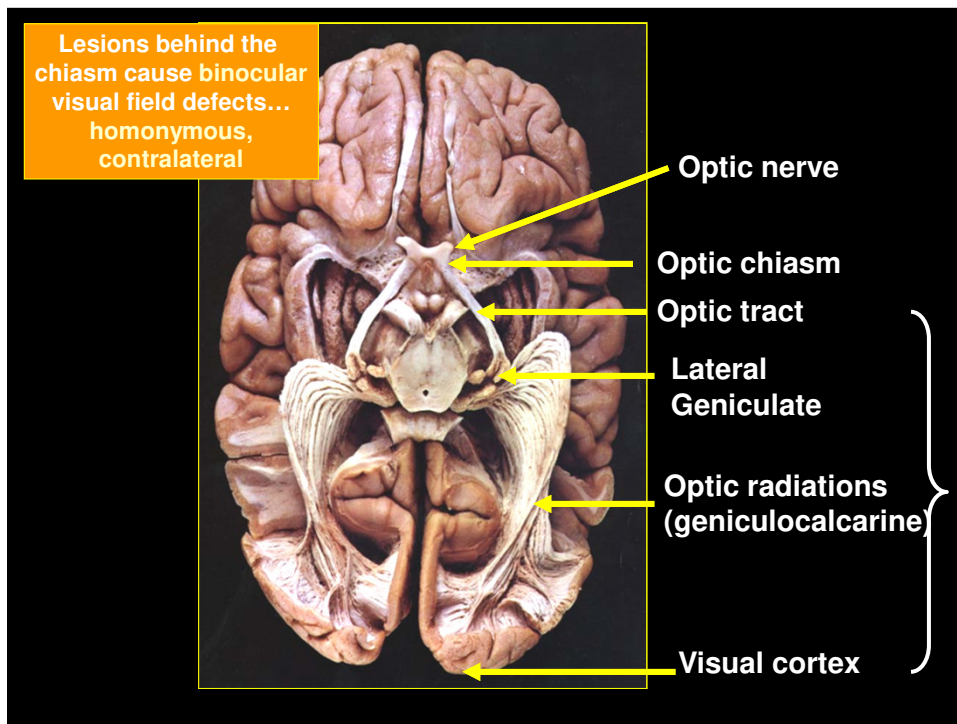
70 y/o AA Woman

- C/o progressive difficulty seeing objects to her right x 4 months
- BVA:
 - 20/20 OD
 - 20/20 OS

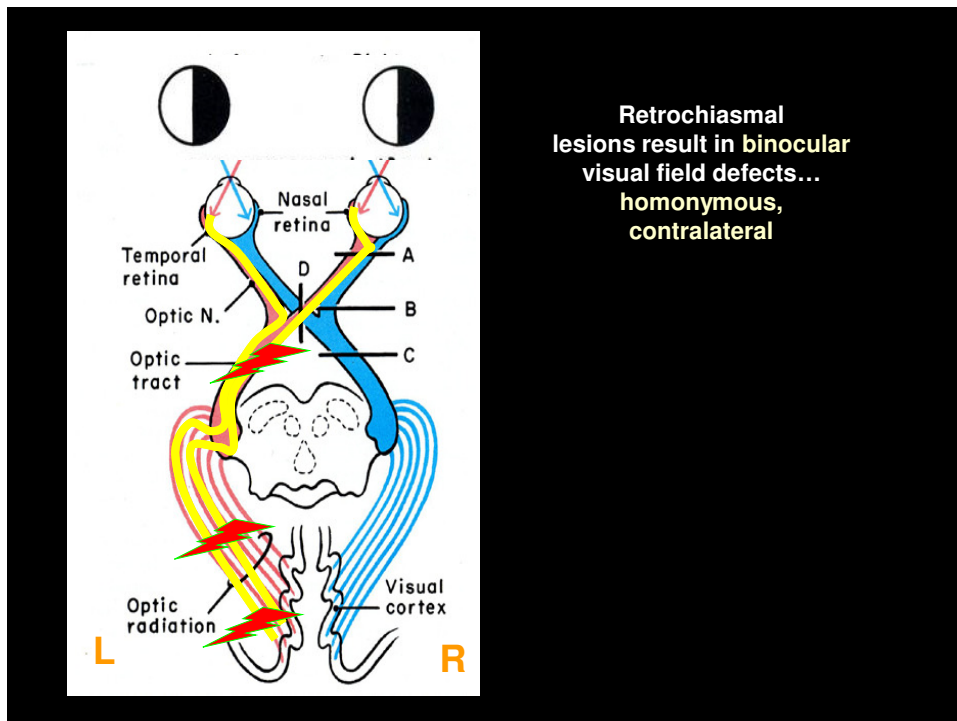
157



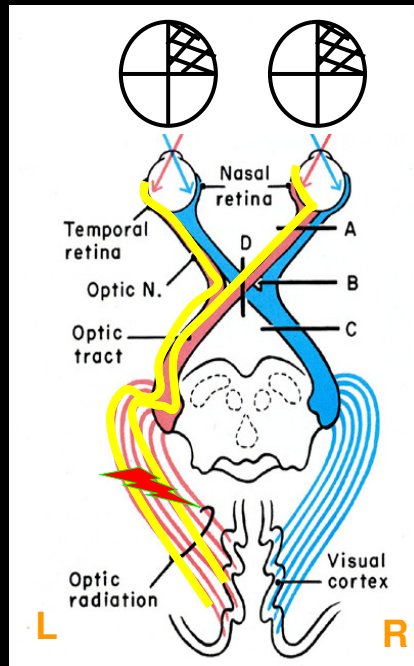
158



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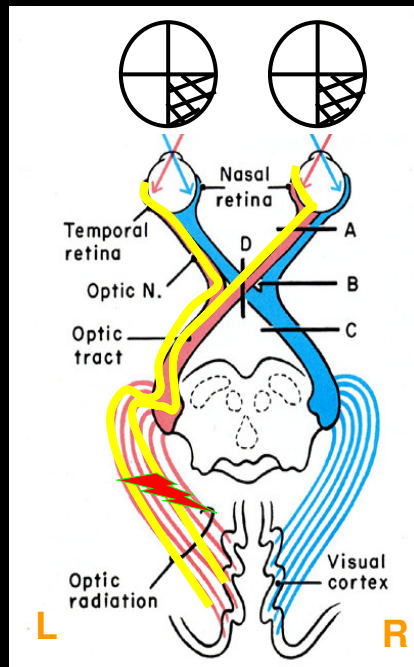
Temporal lobe lesion



Inferior retinal quadrants

Related neurologic problems:
Memory/auditory dysfunction,
seizures

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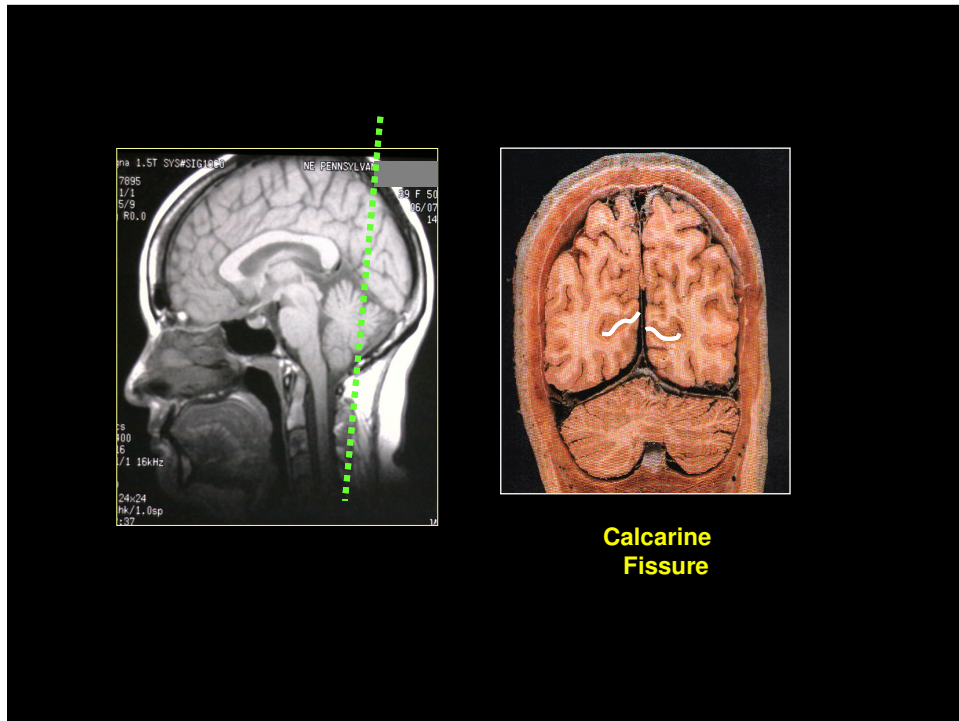
Parietal lobe lesion

superior retinal quadrants



Related neurologic problems:
Neglect of non-dominant side,
agnosia, apraxia, math difficulty,
abn. saccades

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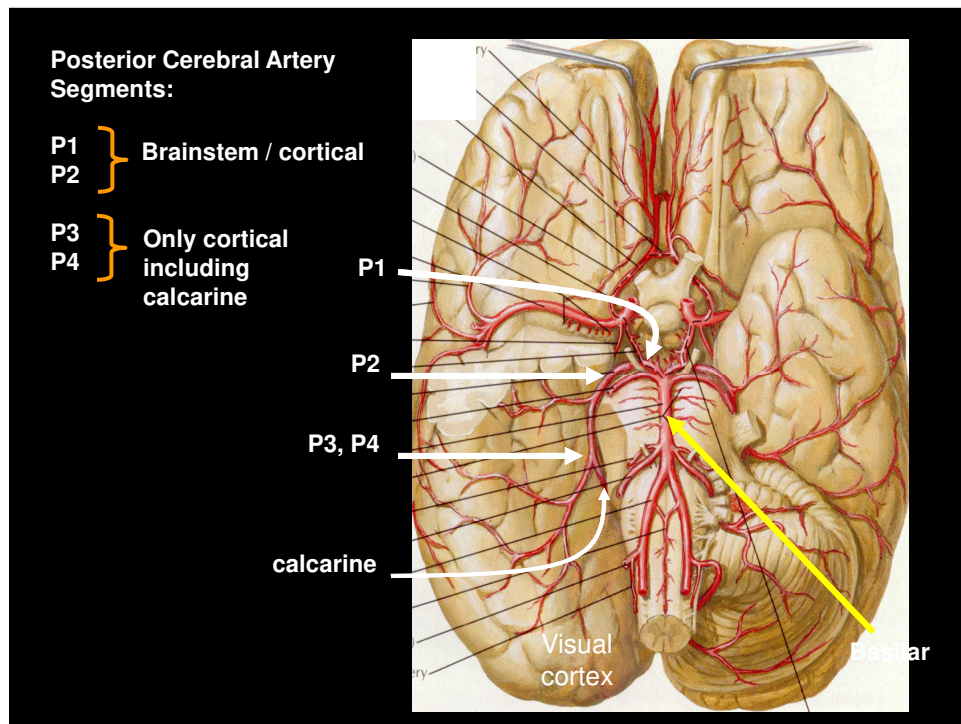


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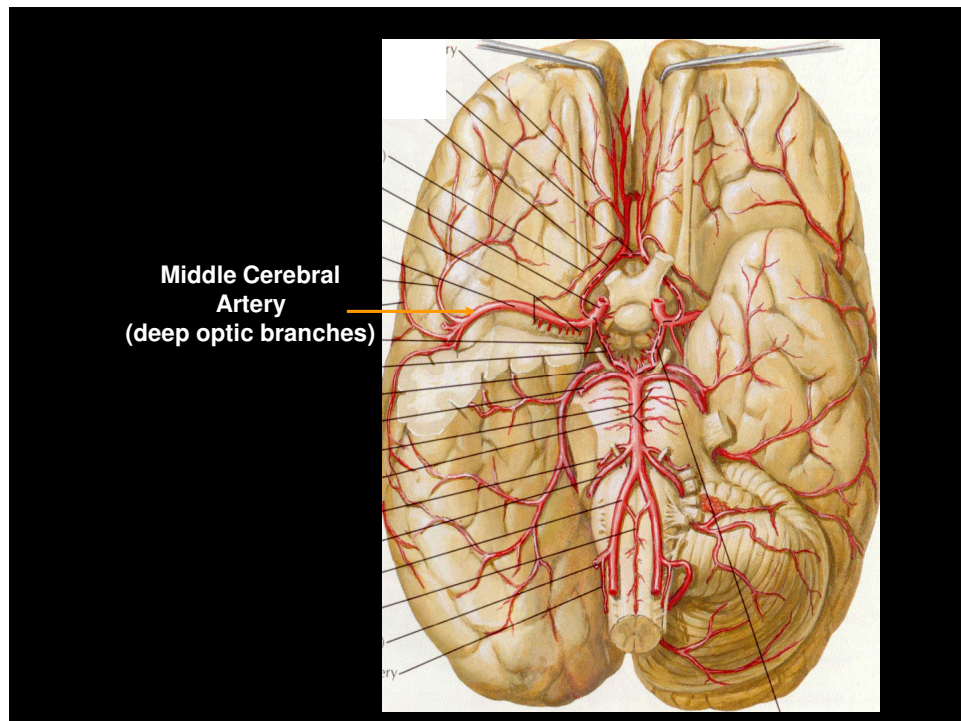
Blood Supply to Occipital Lobes

- P3/P4 branches of the posterior cerebral artery (medial aspect)
 - Calcarine branch
 - Posterior lateral PCA branch
- Middle cerebral artery (lateral aspect)
 - deep optic branches

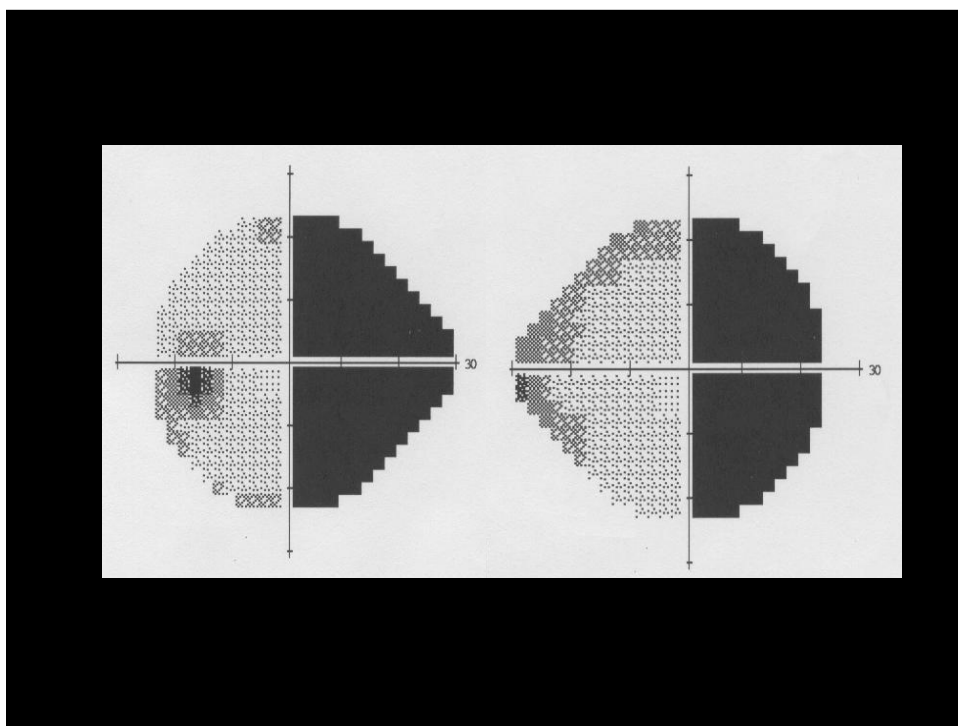
164



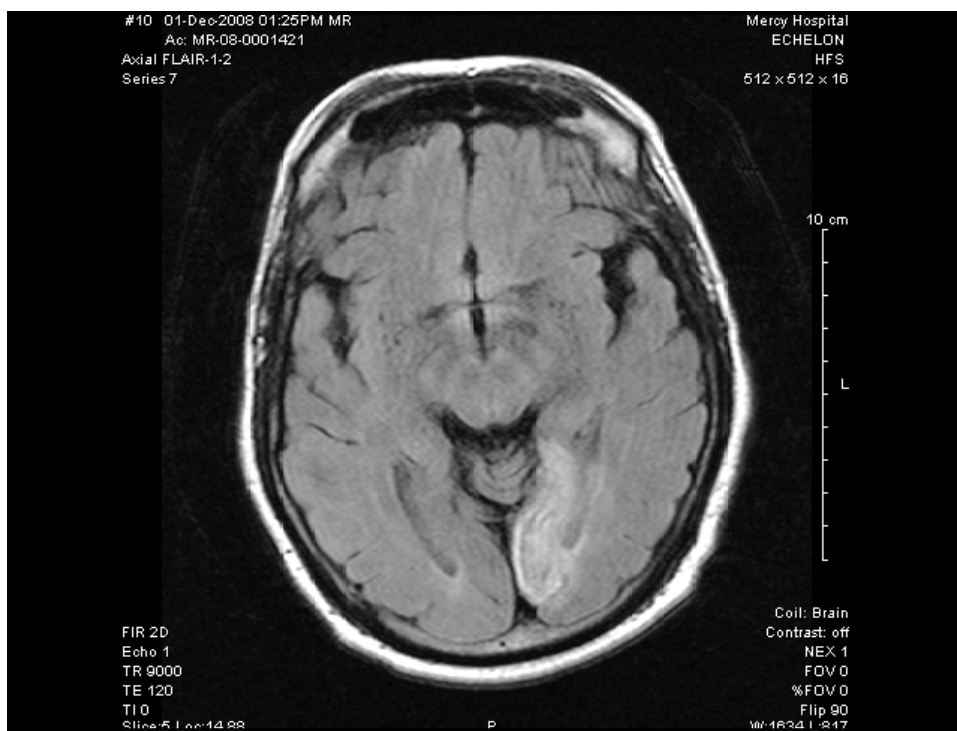
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Posterior Cerebral Artery Infarction

- 5-10% of cerebral infarcts
- 5% stroke-related death (P1 & P2 segments)
- 84% *chronic visual field defects (P3 & P4 segments)*

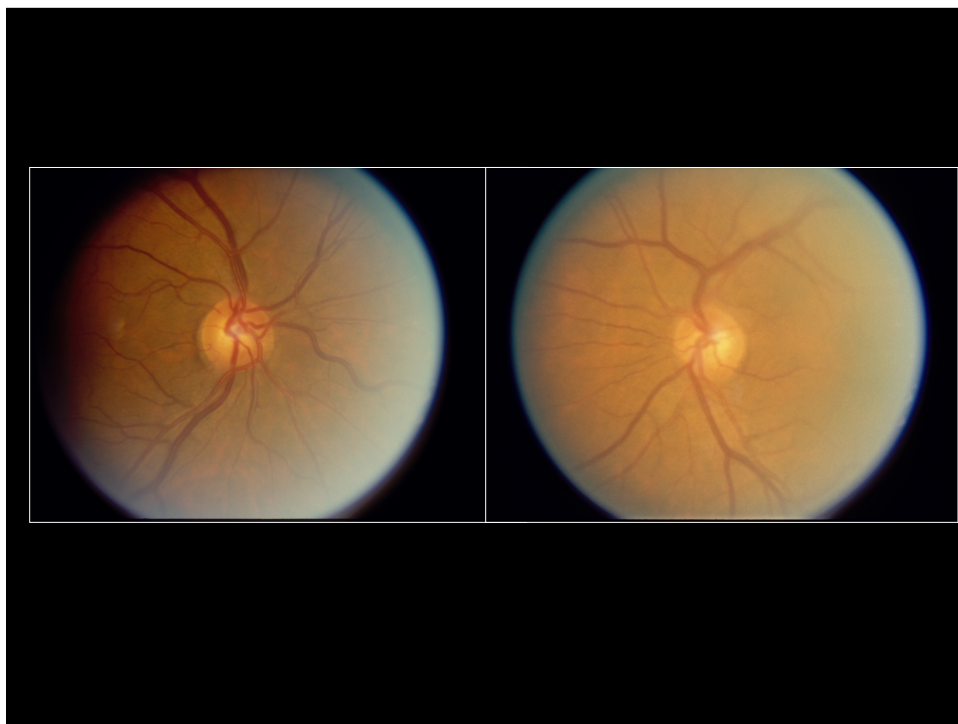
Brandt T, et al. *Cerebrovasc Dis* 2000

169

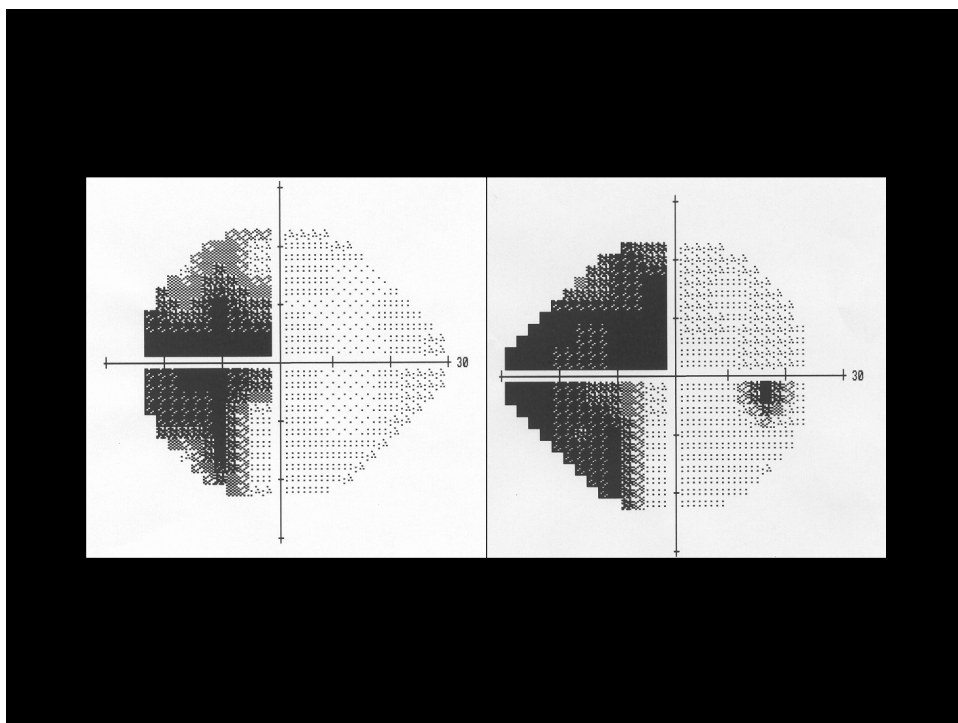
A 58-y/o Man

- C/o recent onset vision loss on left side
- BVA: 20/20 OU
- PMI: HTN x 20 years

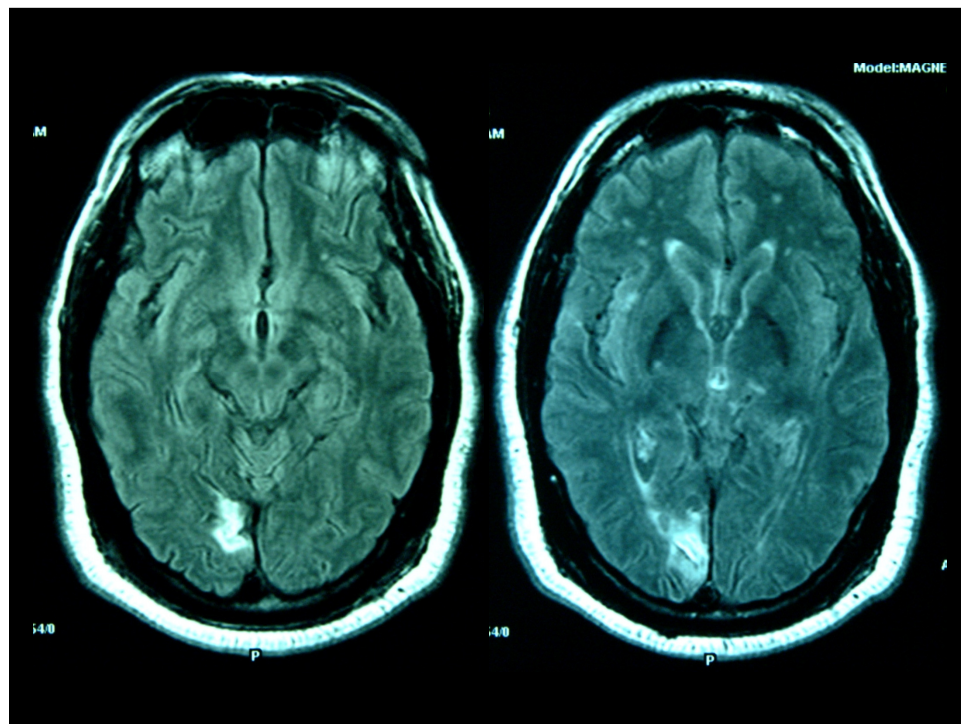
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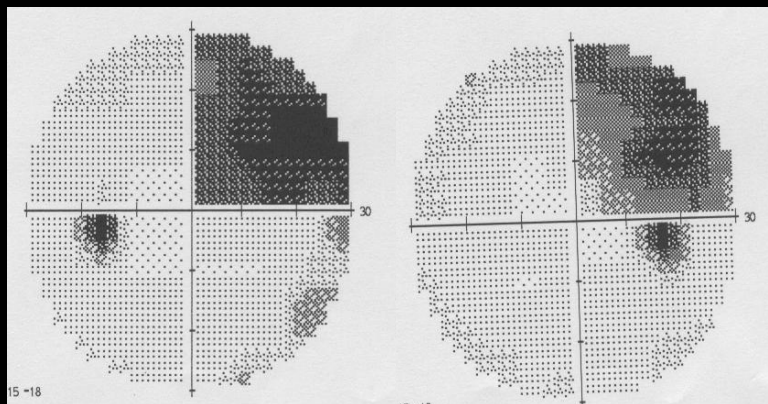


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56 y/o Hispanic Male

- C/o difficulty seeing objects up & to his right
- BVA:
 - 20/20 OD
 - 20/20 OS

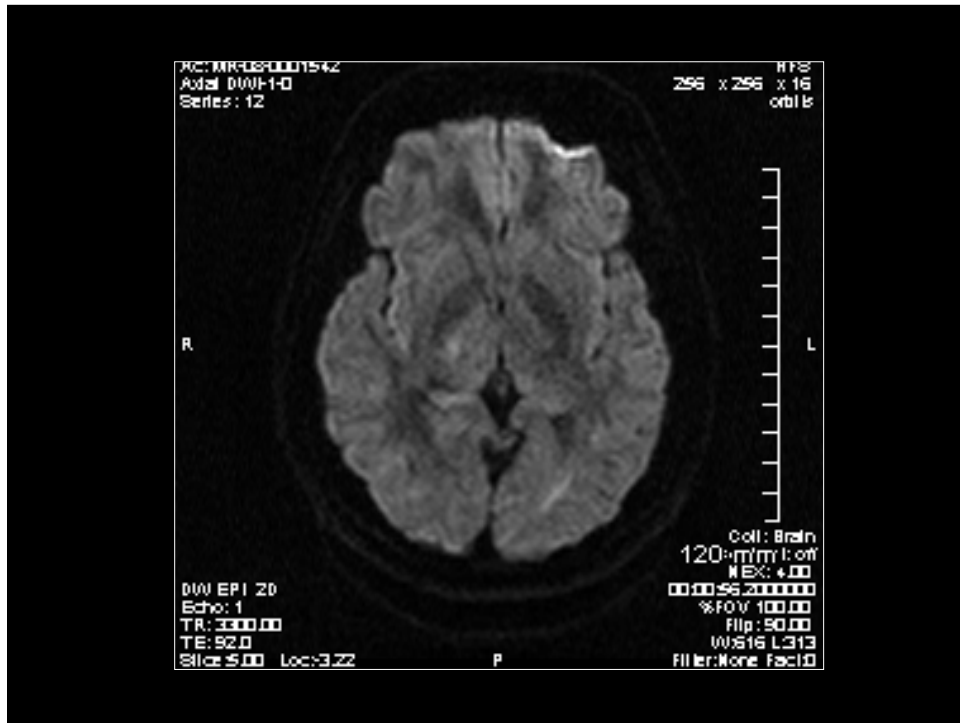
174



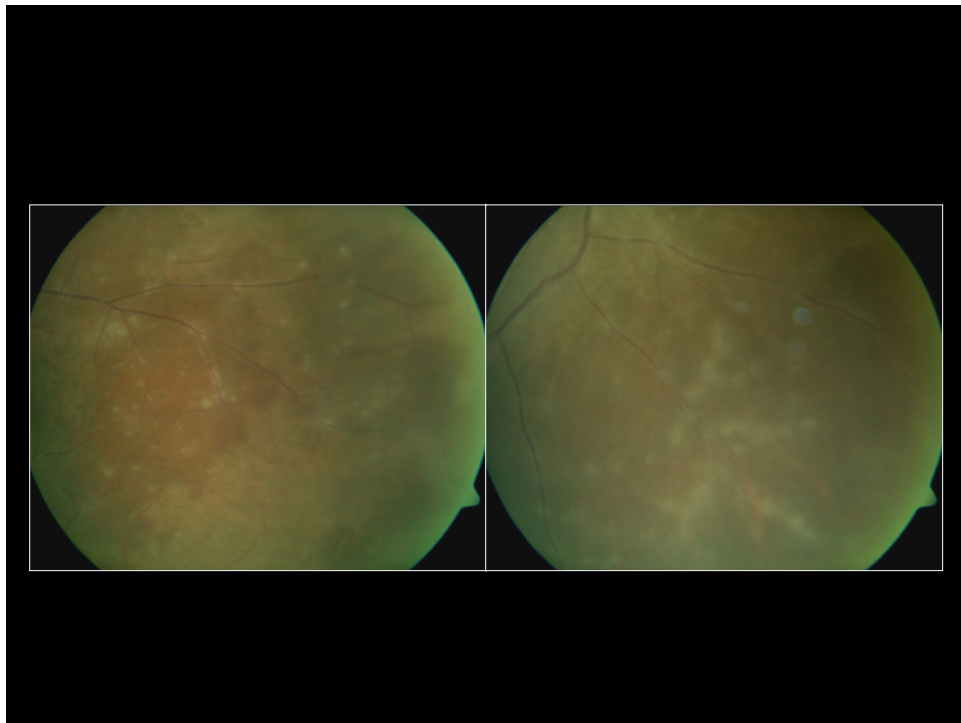
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The Rest of the Story...

- Treated for gonorrhea 30 yrs. ago
- **Serology:**
 - + FTA-Abs
- **CSF:**
 - Protein (86.7 mg/100 ml)
 - IgG (14.7 mg/100 ml)
 - IgM (2.0 mg/100 ml)
 - + VDRL

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CNS Syphilitic Vasculitis

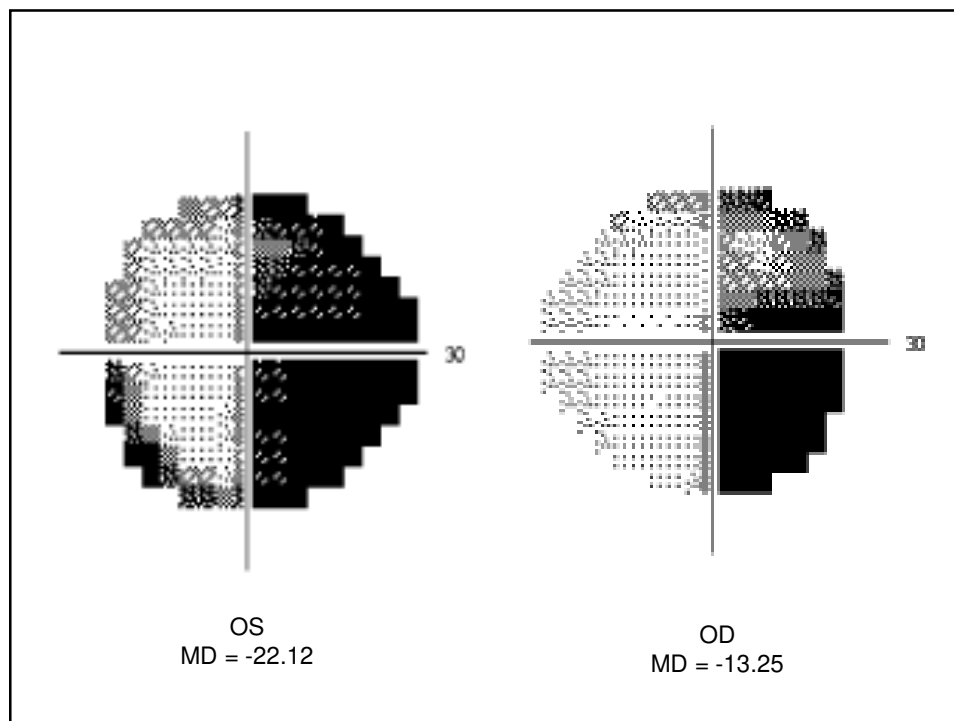
- Positive FTA-Abs / CSF VDRL
- Elevated protein and pleocytosis
- Commonly along distribution of **middle cerebral artery** (less often with basilar artery distribution)

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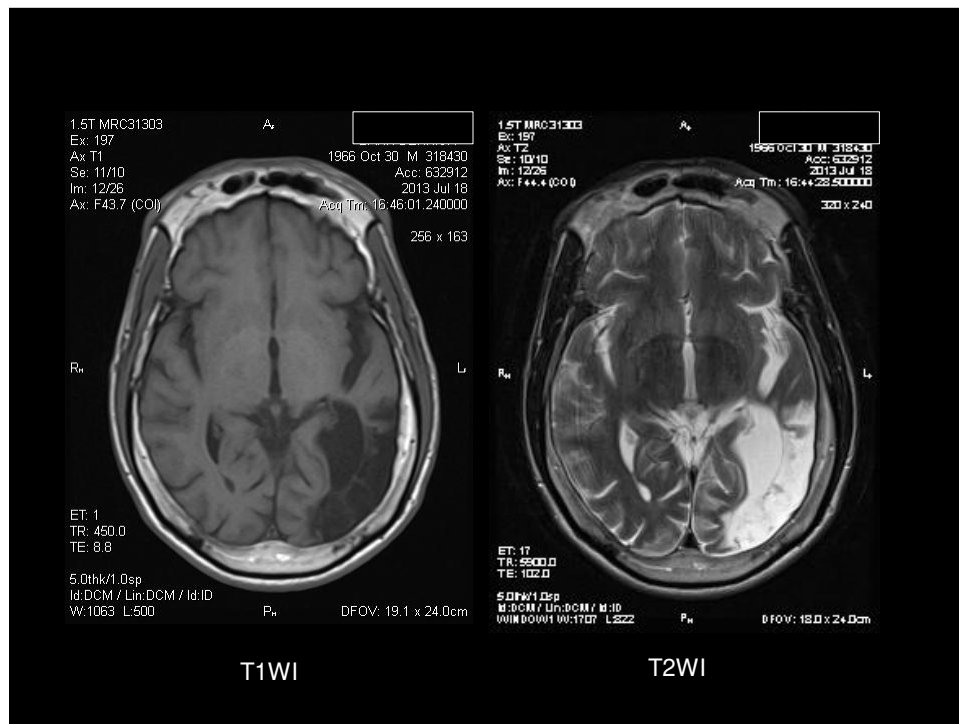
46 y/o AA Male

- C/o difficulty seeing objects to his right (approx. 6 mos)
- Right side hemiparesis
- + HIV & syphilis
- BVA:
 - 20/20 OD
 - 20/20 OS

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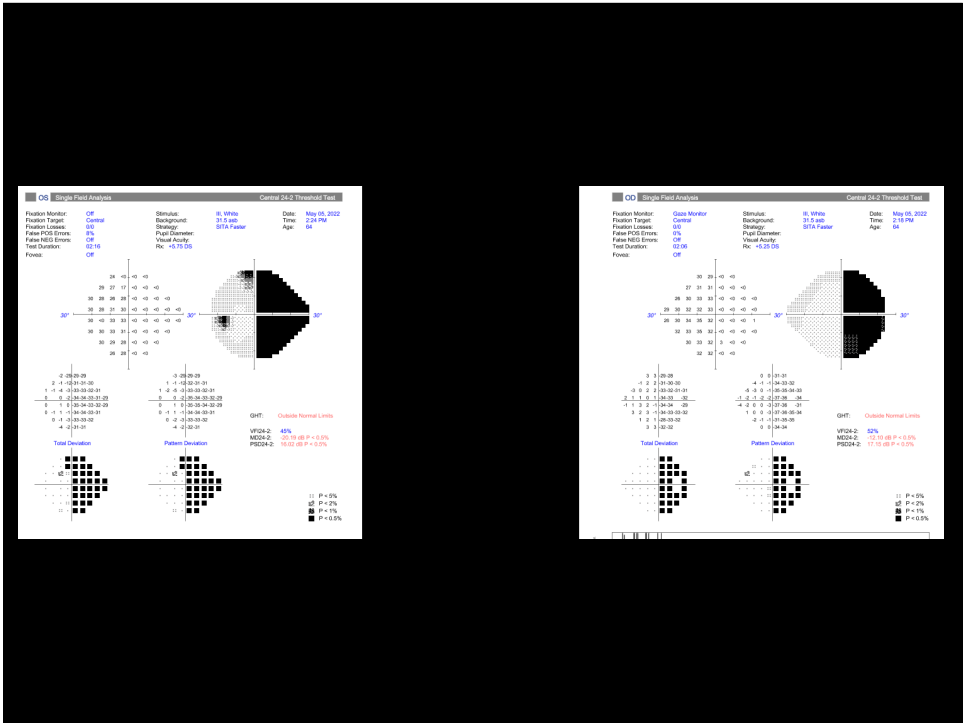


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72-y/o Man

- C/o loss of vision on right side
- BVA: 20/20 OU
- PMI: DM & HTN x 25-30 yrs.

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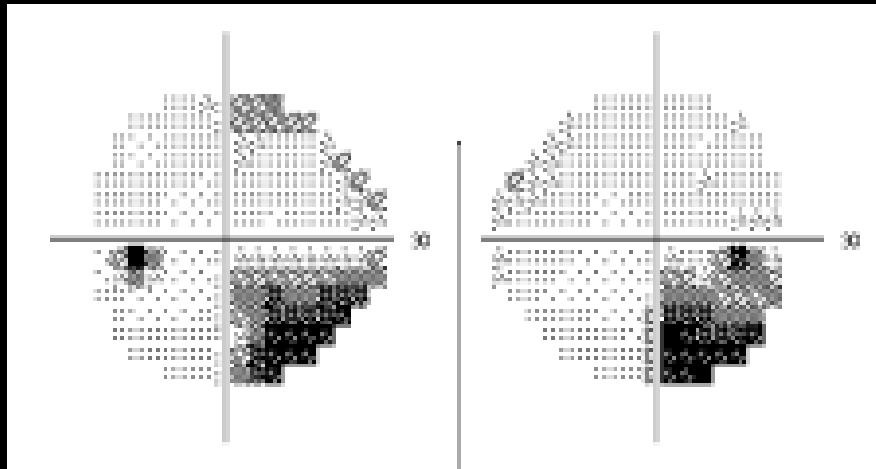


187

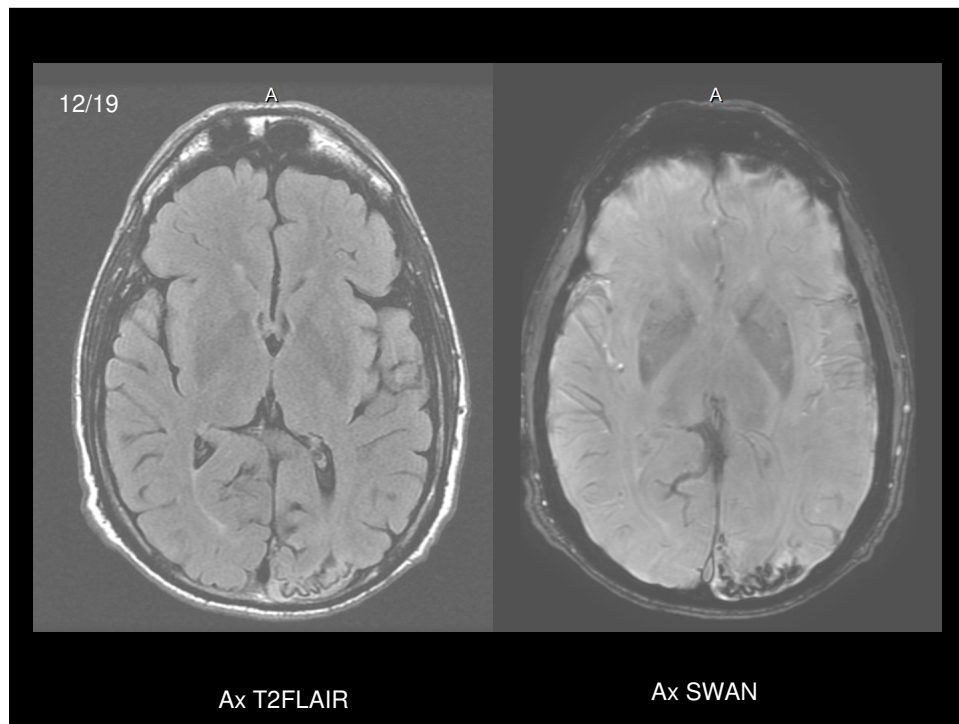
44 y/o AA Man

- C/o difficulty seeing objects down & to his right (“scintillating” quality)
- + seizures
- BVA:
 - 20/20 OD
 - 20/20 OS

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Occipital Lobe Arteriovenous Malformations

- Occipital epilepsy
 - Flashes of light
 - Homonymous field defects (dimming)
- Occipital apoplexy (acute hemorrhage)
 - Sudden onset headaches
 - Homonymous field loss
- *Confusion with migraine*

Troost & Newton Arch Ophthalmol 1975

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Occipital arteriovenous malformations:

Visual disturbances and presentation

M.J. Kupersmith, MD; M.E. Vargas, MD; A. Yashar, MD; M. Madrid, RN, PhD; K. Nelson, MD;
A. Seton, MD; and A. Berenstein, MD

- Retrospective analysis of 68 patients with occipital lobe AVMs
 - Homonymous visual field loss: 57%
 - Headache: 57%
 - Seizures: 29%

Kupersmith MJ, et al. *Neurology* 1996

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Treatment Options

- 30% natural risk of hemorrhage (highest risk with thalamic, basal ganglia & brainstem AVMs)
 - Resection
 - Radiosurgery
 - Embolization
 - Observation

Yang Y, et al. *Neurosurgery* 2014

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Key Points

- Neuroanatomical planes of the body
- Correlative neuro-anatomy and neuroradiology & other imaging for visual pathway lesions
 - Chiasm
 - Retro-chiasm

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Thank you!



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