BRAIN INSULT:
You Are a Piece of The Puzzle

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In addition to the NCAA Division I athletes, she is a primary referral source of Children's of Alabama Concussion Clinic.

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What are your possible "puzzle pieces"

-Identify that a brain insult is present

- History and exam

-Help diagnose the etiology of the brain insult

- Imaging sometimes needed

-Arrange for the patient to get any medical / specialist care that they need

- ED vs outpatient referral

-Rehabilitation

- Glasses, VT, prisms, etc

Acquired Brain Injury

THIS TERM IS MISLEADING

ACQUIRED

A person can be born with brain injury
They would still need services to help them function, even though they do not have ACQUIRED brain injury

BRAIN

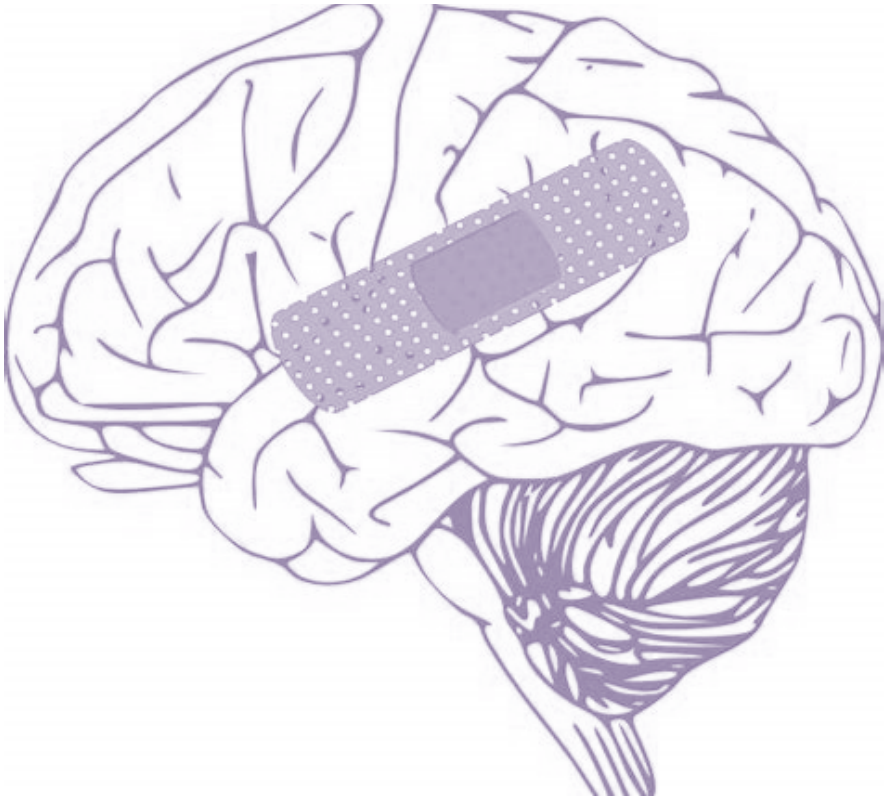
Can be damage to brain but also spinal cord

INJURY

This makes it sound like it has to be from external trauma
It really can be any type of damage, either traumatic or non-traumatic, and from either an external or internal source

- So, a better way to think about it is:

ANY NEUROLOGIC DAMAGE



4 Main Categories of Brain Insult

- Traumatic Brain Injury
- Tumor
- Stroke
- Neurodegenerative Disease

We will go through a case of each of these.

There are other, less common causes

- Infection
- Poisoning
- Hypoxia
- Encephalopathy
- Substance Abuse
- …

No 2 Brain Insults are Alike

- Patient's experiences are unique depending on many factors
    - Nature of the injury/damage
    - Severity of the injury/damage
    - Exact anatomic location of the injury/damage
    - Effects of the ABI
        - Physical
        - Intellectual
        - Behavioral
        - Social
        - Emotional

Patients will need the proper team of providers to help with these effects.

We are part of that team!

One thing ALL brain insults have in common

- Some part of a person's life will be ADVERSELY AFFECTED
- Life adjustments (major or minor) will now be needed
- Recovery is dependent on rapid identification, treatment and rehabilitation

Patients will present differently

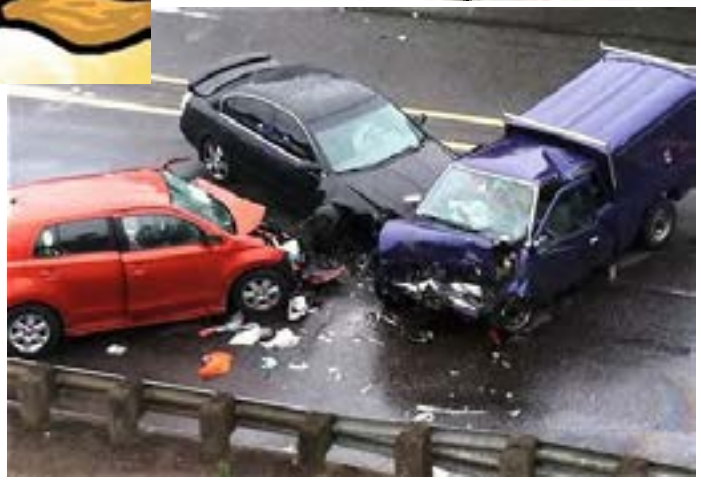
Sometimes, the patient will present knowing something happened (trauma).

However, other times, they just have some visual complaints, and you will have to determine that there is brain insult.

TBI Background Information

TBI

- Most common in varying age groups
  - 1. Older adults (>75 years)
  - 2. Very young (0-4 years)
  - 3. Young adults (15-24 years)
    - Sports injury a common cause in adolescents



The most common causes of TBI:

1. **FALLS in the older population**
2. **Being struck by an object**
3. **Motor vehicle accidents**

TRAUMATIC BRAIN INJURY (TBI)

- CLASSIFICATION USING GLASCOW COMA SCALE (GCS)
  - MILD (GCS score of 13-15)
  - MODERATE (GCS score of 9-12)
  - SEVERE (GCS score of <8)

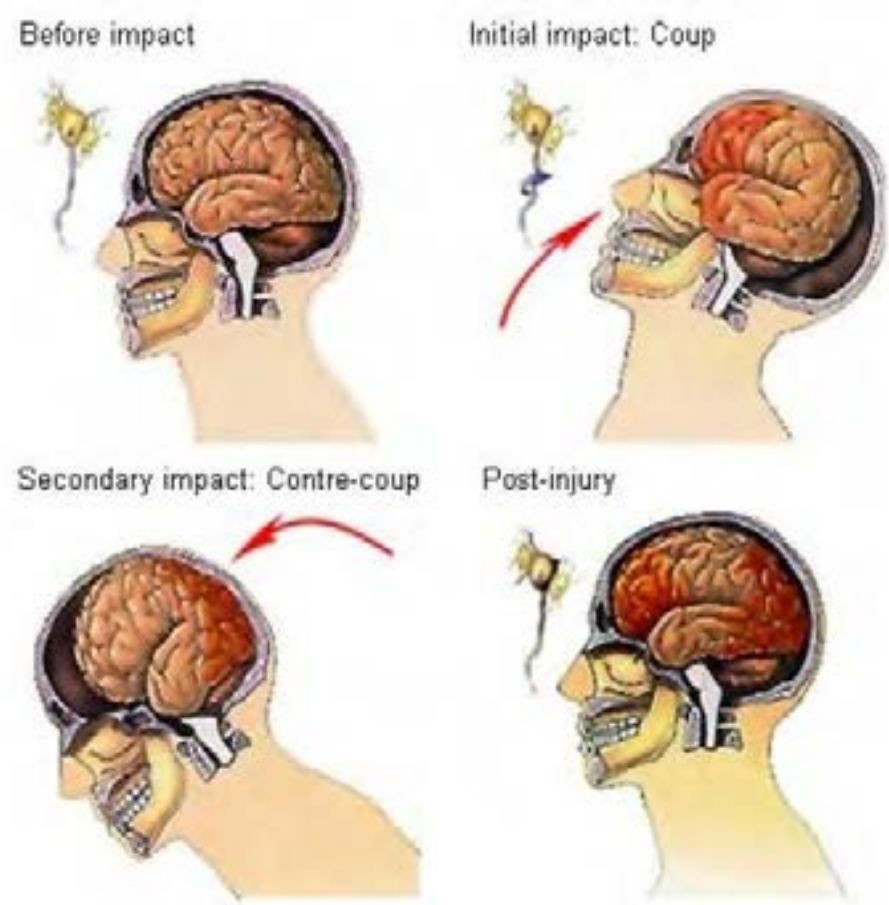
- Mild TBI is usually due to contact or acceleration /deceleration forces
- Concussion is often used to identify mild TBI

Glasgow Coma Scale

BEHAVIOR	RESPONSE	SCORE
Eye opening response	Spontaneously	4
	To speech	3
	To pain	2
	No response	1
Best verbal response	Oriented to time, place, and person	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	No response	1
Best motor response	Obeys commands	6
	Moves to localized pain	5
	Flexion withdrawal from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	No response	1
Total score:	*Best response*	15
	Comatose client	8 or less
	Totally unresponsive	3

CONCUSSION

- Trauma-induced alteration in mental status that may or may not involve loss of consciousness



Mild Traumatic Brain Injury (mTBI)

- An acute brain injury resulting from mechanical energy to the head from external physical forces.
- **Concussion = mild TBI**
- Can be associated with confusion, amnesia, and loss of consciousness

- **Does <u>not</u> have to have associated loss of consciousness**

TBI Symptoms / Post-Concussion Syndrome

- Eyestrain
- Headache
- Blur
- Diplopia
- Loss of concentration
- Sleepiness
- Dizziness
- Balance Issues
- Light Sensitivity
- Noise Sensitivity
- Anxiety
- Depression
- Difficulty Making Decisions
- Sleep Disturbance

Although most symptoms will resolve with time, 15% of mTBI patients have disabling symptoms after 1 year!

SLEEP DISTURBANCES IN TBI

- Seen in ALL classifications of TBI
- Excessive daytime sleepiness
- Increased sleep need
- Insomnia
- Sleep fragmentation

TBI and VISUAL SYMPTOMS

- visual symptoms occur in MOST (75%) individuals with concussion

- blurred vision, poor visual focus, difficult reading, diplopia, rarely shaking vision (i.e., oscillopsia), photophobia, intolerance of visual activities, headaches, and dizziness.

- Poor tolerance of visual activities such as screen use and scrolling on smart phones is common

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Concussion and Vision Literature in Children Prevalence Studies: Signs

Study	N	Ave. age	Study Design	Conv Insuff	Accomm Insuff	Eye Tracking	Visual Field	Specialty if not Eye Care
Master C Scheiman M 2016	**100**	**14.5**	**pro**	**49%**	**51%**	**29%**		
Pearce KL 2015	**78**	**14**	**pro**	**42%**				Ortho
Stelmack 2009	103		retro	28%	47%	6%	14%	
Brahm 2009	191		retro	42%	42%	33%	32%	
Goodrich 2007	50		retro	30%	22%	20%	21%	Psychology
Suchoff 1999	62	19-70		42%	10%	40%	32%	
Normal population				**BV = 5%**	**3%**	**2%**		

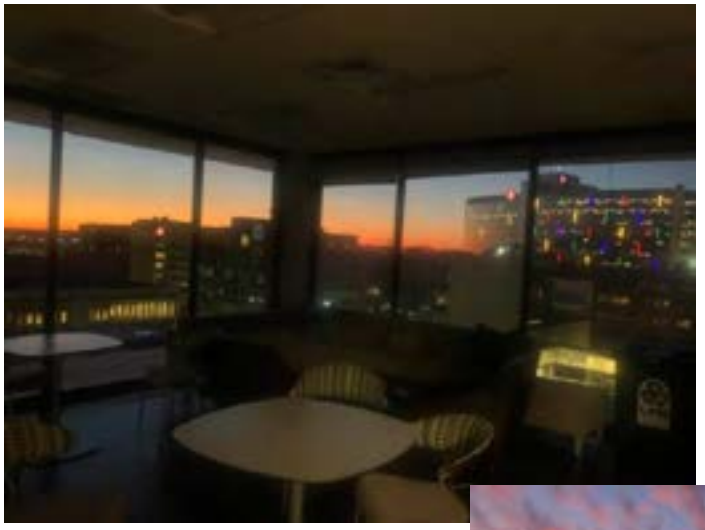
M. Scheiman

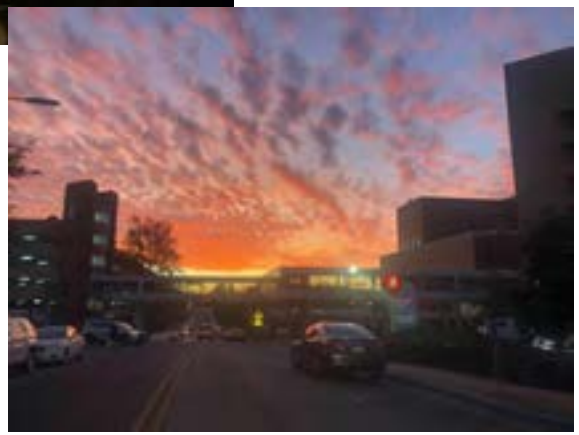
CASE 1

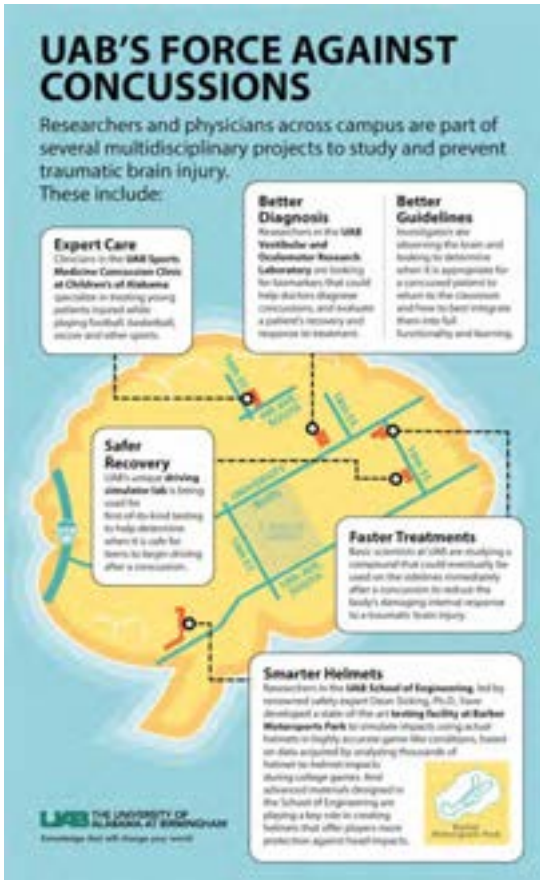
TBI

14 yo beautiful WF with strong mama and with history of concussion

What do you want to know about referral source?







1. ATC/Coach
2. Pediatrician
3. Team Physician
4. Neurologist
5. Neuropsych
6. Peds Rehab
7. Parent

What do you want to know about referral source?

1. Who
2. Where
3. When
4. Who’s driving the bus?

What do you want to know about the injury?

- Date of injury
- Loss of consciousness
- Event amnesia
- How many concussions prior?
- MRI or CT?

What symptoms (visual or general) might she have?

- Dizziness
- loss of concentration
- brain fog
- academic difficulty
- Imbalance
- Vertigo
- Not herself
- Headaches
- Sleep issues
- Photophobia
- Difficulty switching from board to desk
- “Grocery store” (high school hallway) syndrome
  - VMS on VOMS (eyes look at thumbs; torso turns back and forth in front of busy backgound)

What do you want to ask about school?

- Full time? Part time? At home?
- Passive? Active learning? Tests?
  - "Sponge learning"
- After school activities?
- Return to play?
- Accommodations (large print, sunglasses, leave class early, water at desk, reader/aide, earplugs, fewer items on page, no devices, double-sided copies, no devices)

What other systemic conditions might go along with concussion?

- ADD/ADHD,
- depression,
- Anxiety

Something to consider:
Concussion may be less likely to *cause* these and more likely that it *lowers tolerance*.

Can you think of any other questions to consider?

- 1. Other doctors?
  - Vestibular
  - Vision
  - PT
  - Counseling
  - Audiology
- 2. Who's driving the bus? Who's overseeing all care?
- 3. Getting better or worse?
- 4. Scale of 1-100, how old are to your old self?

What objective tests do you want to consider that tells us how the eyes are messed up after concussion?

- VA's (PH?)
  - 20/20 OD, OS
- Cover Test
  - 0-1 XP
  - 0-6 XP'
- Amps (age minimums)
- MEM
  - Pl to 0.75 D
- Facility
  - +/-2.00 facility
    - (normal ~10-12 cpm)
  - 3 BI/12 BO facility
    - (normal ~15 cpm)
- NRA/PRA
  - +2.50/-2.50
- Vergences
  - Double demand/Cover Test
- DEM
  - Normative Data
- CISS
  - ≥16 child = symptomatic
  - ≥21 adult = symptomatic
- Refractive error (wet and dry)

What objective tests do you want to consider that tells us how we can use the eyes to tell us about the brain after concussion?

- (DFE? Yes, unless contra indicated…T1-4'-T1)
- CF
- EOM's
- Pupils
  - Pupillometer
- OCT
  - ONH, GCC
- VF
  - 120-point neuro screener
- VOMS or SVV

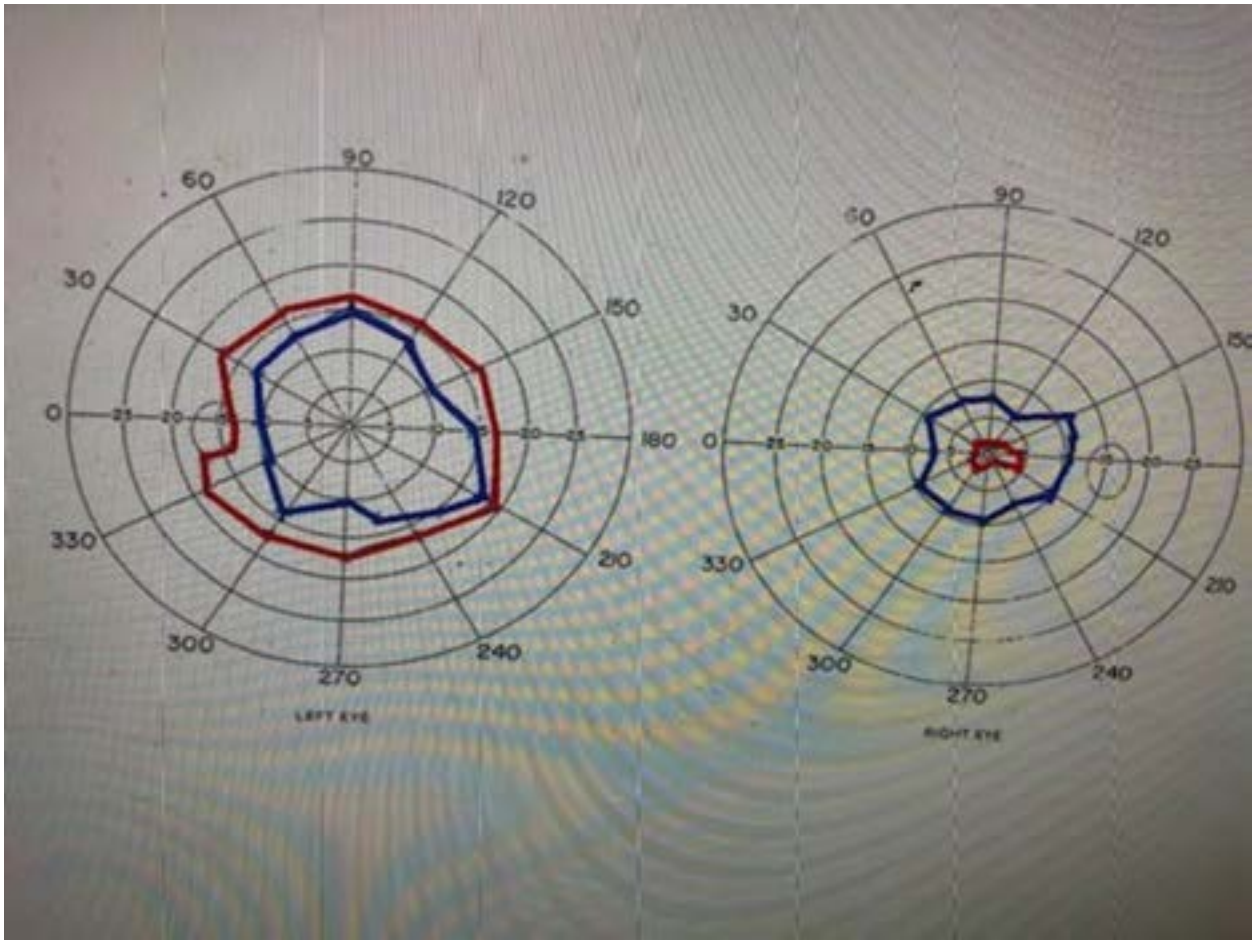
Assessments for our Patient

- Accommodative insufficiency:
  - Difficulty keeping near work clear, which could cause intermittent blur and eye strain
  - 5 D OD, OS: Eyes of a 40 year old
- Accommodative infacility/(vergence infacility)
  - Difficulty switching focus from distance to near to keep things clear (and single)
- Good convergence, good eye tracking, good objective pupil function
- Minimal need for glasses in the absence of concussion
  - +0.50 D, OD, OS
- Subnormal distance visual acuity (20/30 OD, OS)

Anterior and posterior seg are normal as they typically are; what other diagnoses and tests should we consider?

- PH
- Tangent screen

Tangent screen – visit 1

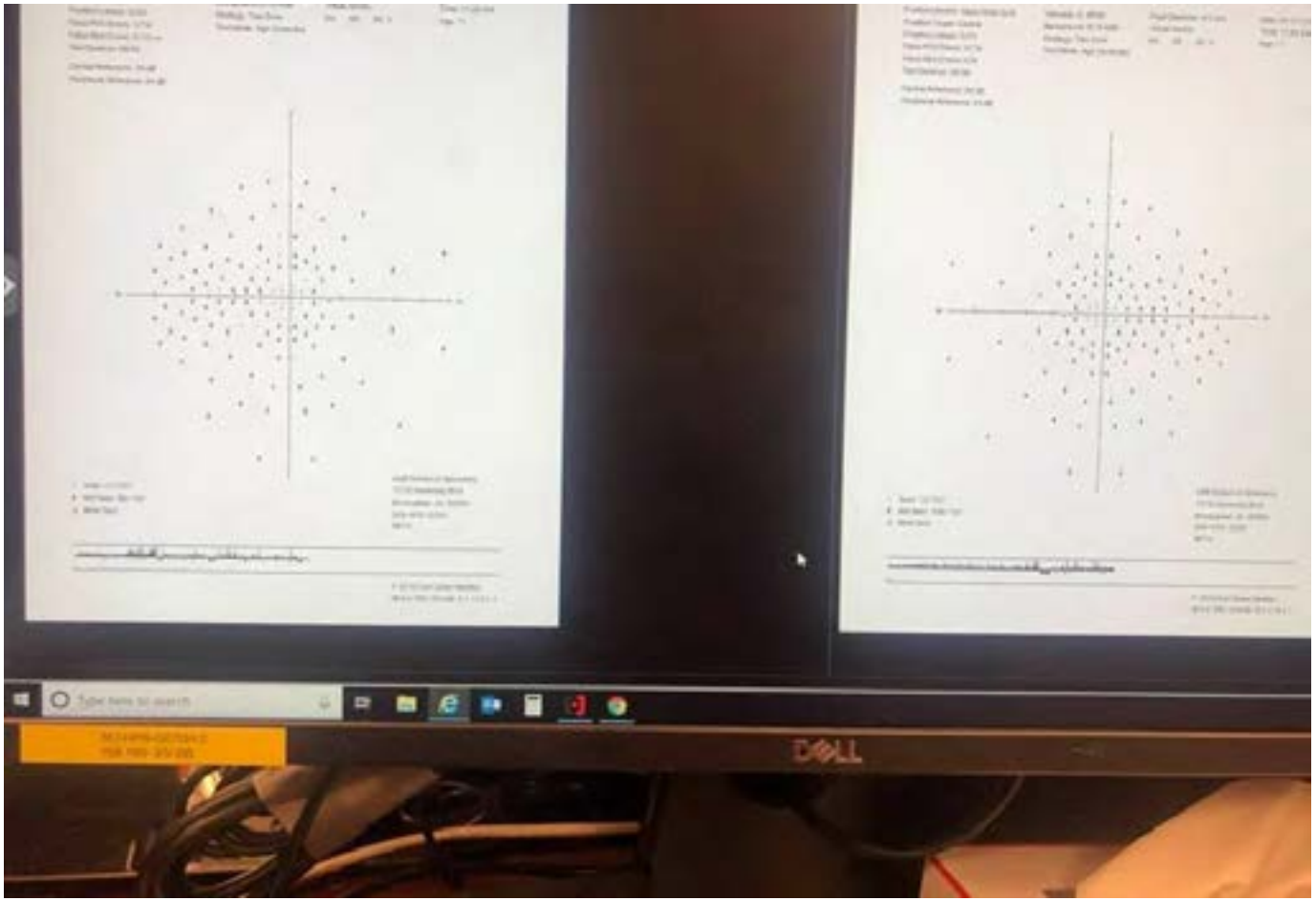


What's your concern/diagnosis?

- Psychogenic amblyopia
- Conversion reaction
- Functional vision loss

Do you want to see 120-point screener?

Do you want to see 120-point screener?



PANEL DISCUSSION

What's your added diagnosis?

- Pyschogenic amblyopia
- Conversion reaction
- Functional vision loss

FVL: Peds vs. mTBEye Clinic

Vinogradov H, Weise KK, Swanson MW, et al

- N = 58 (Peds) and 54 (mTBEye)
  - Age: 9 to 17 years
    - Peds: 12.5 (2.3)
    - mTBEye: 12.9 (2.5)

FVL: Peds vs. mTBEye Clinic

Vinogradov H, Weise KK, Swanson MW, et al

- FVL
  - Peds: 1.7% (1/58)
  - mTBEye: 16.7% (9/54)
    - VA only: 11.2% (1/9)
    - VF only: 44.4% (4/9)
    - VA + VF: 44.4% (4/9)
    - + Accommodative Spasm: 11.1% (6/54)

FVL: 27.8% (15/54)

What causes FVL?

- Mood disorders?? (Old school)
  - Stress
  - Anxiety
  - Depression
- Or not (new thinking)
  - Espay AJ, Aybek S, Carson A, Edwards MJ, Goldstein LH, Hallett M, LaFaver K, LaFrance WC Jr, Lang AE, Nicholson T, Nielsen G, Reuber M, Voon V, Stone J, Morgante F. Current Concepts in Diagnosis and Treatment of Functional Neurological Disorders. JAMA Neurol. 2018 Sep 1;75(9):1132-1141. doi: 10.1001/jamaneurol.2018.1264. PMID: 29868890; PMCID: PMC7293766.
  - Not all smokers get lung cancer and not all lung cancer is from smoking.
  - Let's go back to the neuro roadways prior to the construction detours.

What are your management suggestions?

- 1. No glasses to see clearly in the absence of concussion, but perhaps helpful to see more comfortably
  - Anti-fatigues…Hoya Sync 9 or Eyezen3
- 2. Referral for counseling
  - Neuropsych?
  - School counselor?
  - Or Functional Neurological Disorder (FND) expert

Concussion Management Options

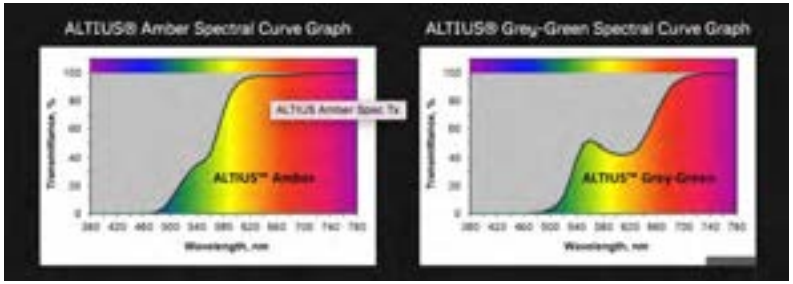
_1. Glasses/Contacts

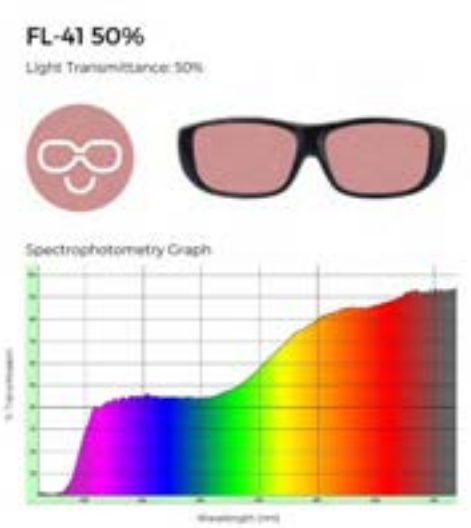
- Normal prescribing patters +
- Lower hyperopia thresholds
- Adds
  - Anti-fatigues (Hoya or Eyezen) (or readers)
    - SV but shaped like a PAL
    - Low add on bottom (0.5, 0.9, 1.3)
  - OTC Readers?
  - Multi-focal contact lenses?
- Anti-reflective coat = a must

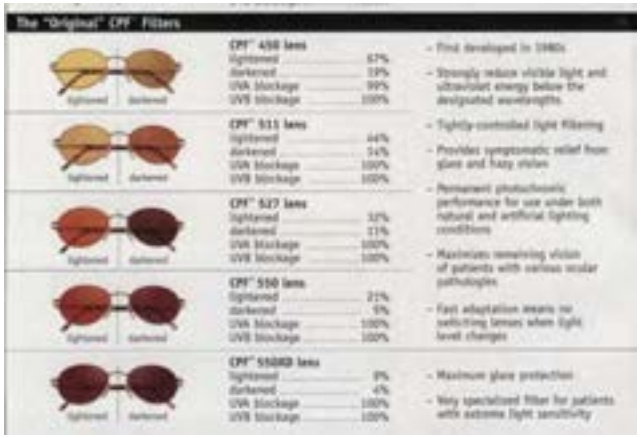
Concussion Management Options

2. Photophobia options

- "Neurophotophobia"
  - ipRGC's?
  - Trigeminal CN 5?





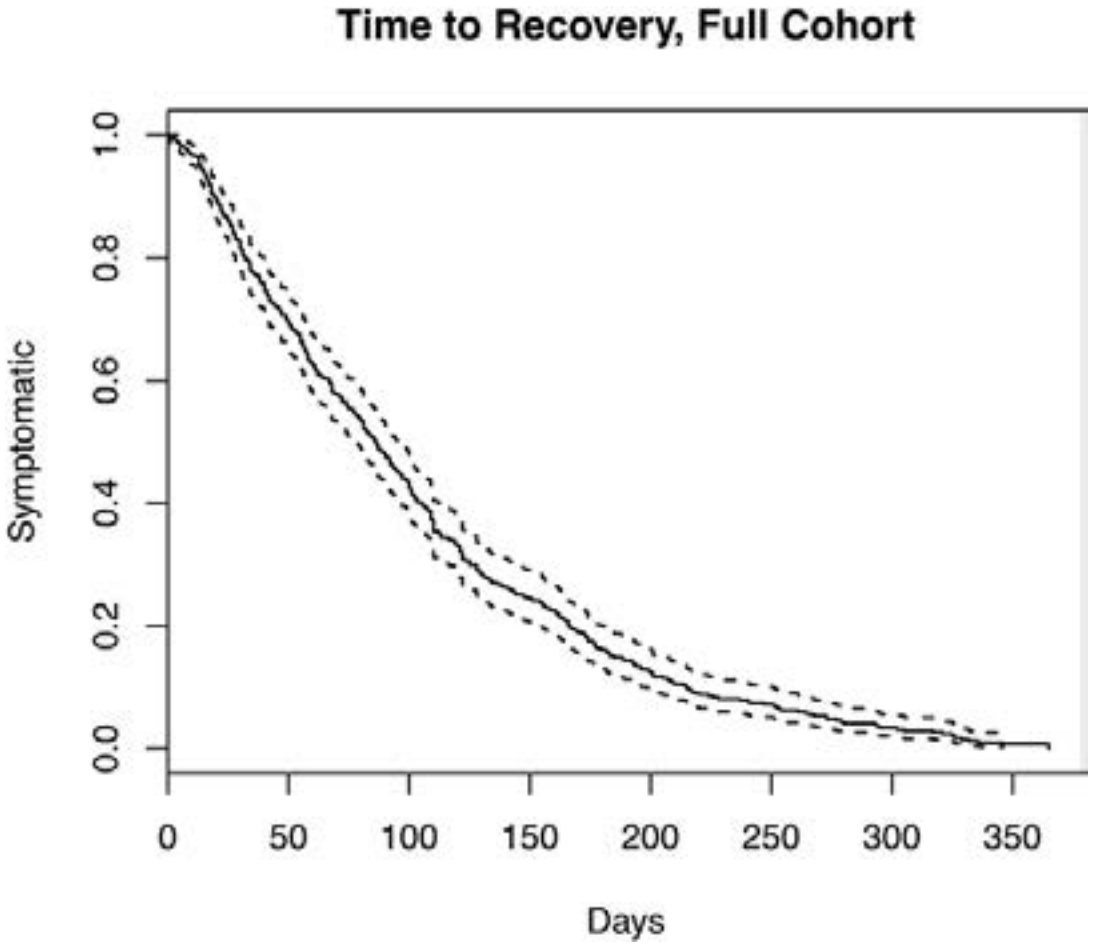


Concussion Management Options

–

- 3. VT
- 4. Vestibular referral
  - VOMS abnormal or high CISS with minimal clinical findings
- 5. Classroom adjustments
- 6. Other referrals

Master CL, Master SR, Wiebe DJ, Storey EP, Lockyer JE, Podolak OE, Grady MF. Vision and Vestibular System Dysfunction Predicts Prolonged Concussion Recovery in Children. Clin J Sport Med. 2018 Mar;28(2):139-145.



3 Most Common Visual Problems Associated with mild TBI

- **Convergence Insufficiency**
- **Accommodative Dysfunction**
- **Oculomotor Dysfunction**

The midbrain is the center for convergence. The rostral midbrain is known to be highly biomechanically susceptible to injury from head impacts.

CI has been reported in more than half of individuals with concussion.

Convergence insufficiency is the most common ocular motor finding in concussion.

CI has been associated with higher overall concussion symptom burdens and longer recovery times.

Convergence Abnormalities in TBI

- After TBI, there can be not only convergence insufficiency, but also abnormal **convergence endurance**
  - Can initially read, but difficulty sustaining convergence
  - Difficulty with prolonged reading

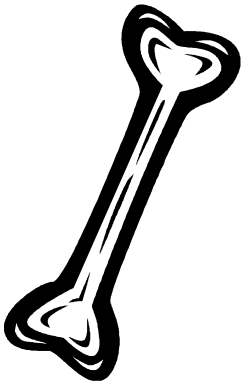
Imaging for Head Trauma

- Computed Tomography (CT) imaging is the first-line imaging in head injury:
    - CT has higher spatial resolution than MRI
    - CT is more sensitive than MRI for the evaluation of the osseous calvarium, provides exceptional sensitivity for hemorrhage, and makes possible the detection of foreign objects inside the calvarium that would preclude MRI
    - CT is also cheaper, more readily available, and much faster than MRI

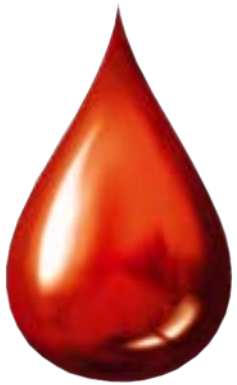
Guenette JP, Shenton ME, Koerte IK. Imaging of Concussion in Young Athletes. Neuroimaging Clin N Am. 2018 Feb;28(1):43-53. doi: 10.1016/j.nic.2017.09.004. PMID: 29157852; PMCID: PMC5728158.

CT for Head Trauma

- Superior to MRI for the following (and contrast not indicated):



Bony Injury



Acute Hemorrhage

Localization of Foreign Bodies

BONE BLOOD BB

Neuroimaging for Concussion

- Only recommend in the setting of suspected concussion in those patients who have:
    - loss of consciousness
    - posttraumatic amnesia
    - persistent Glasgow Coma Scale <15
    - focal neurologic deficit
    - evidence of skull fracture on examination
    - signs of clinical deterioration

Guenette JP, Shenton ME, Koerte IK. Imaging of Concussion in Young Athletes. Neuroimaging Clin N Am. 2018 Feb;28(1):43-53. doi: 10.1016/j.nic.2017.09.004. PMID: 29157852; PMCID: PMC5728158.

Pathologic Injuries in TBI

(more moderate to severe)

- Skull fracture
- Epidural hematoma
- Subdural hematoma
- Subarachnoid hemorrhage
- Intraparenchymal hemorrhage
- Cerebral contusion
- Intraventricular hemorrhage
- Focal or diffuse patterns of axonal injury with cerebral edema

If imaging not done or initially normal, and symptoms worsen, patient needs imaging to rule out subdural hematoma, which may not have been seen on initial imaging.

In Outpatient Setting – mainly mTBI

- Most patients exhibit a normal eye exam, despite of their visual complaints.

- There is a suspicion that higher order visual-cognitive functions have become impaired due to diffuse axonopathy causing deficits in connectivity between visual and cognitive areas of the brain.

- The difficulty in identifying the source of visual complaints underscores the diagnostic and treatment dilemma facing healthcare providers, rehabilitation specialists, employers, teachers, athletic administrators and patients.

This is even more difficult to diagnose when there is an overlying functional component.

POST-TRAUMATIC CRANIAL NERVE INJURY

- Cranial nerve palsies may occur secondary to trauma
- The most common cause of a CN IV palsy is TRAUMA
  - Anterior medullary velum
  - Ambient cistern
  - Free edge of tentorium
  - Trochlea
- Any CN Palsy may occur due to trauma

POST-TRAUMATIC VERTIGO AND DIZZINESS (can present with nystagmus)

- Substantial contributor to disability after mild TBI

- Central Causes
  - Diffuse axonal injury
  - Vestibular migraine
  - Vertebral artery dissection
  - Psychologic factors (anxiety, PTSD, etc)

May need to refer to neurology, ENT, or to PT for vestibular therapy.

- Peripheral Causes
  - BPPV (benign paroxysmal positional vertigo)
    - Shearing and displacement of otoconia into semi-circular canal
    - Injury to cochlear or vestibular structures
    - Labyrinthine concussion

POST-TRAUMATIC EPILEPSY

- Mild TBI is associated with a 2x increase in risk of epilepsy for 5 years after injury
- 80% of seizures will occur in first 2 years
- Seizures in first week do not count as epilepsy
  - Considered an acute symptomatic event
- Half of seizures will occur in 1st year

- PROPHYLACTIC TREATMENT WITH ANTI-SEIZURE MEDICATION DOES NOT PREVENT POST-TRAUMATIC EPILEPSY AND IS NOT RECOMMENDED

Afferent Visual Biomarkers in TBI

- STRUCTURAL BIOMARKERS
  - Thinning of inner retinal layers
  - MRI visual radiations and cortex
- FUNCTIONAL BIOMARKERS
  - Pupil light reflex
  - Contrast sensitivity
  - Visual Field
  - ERG, mfERG
  - Functional MRI
- BIOMARKERS OF LIGHT SENSITIVITY
  - Photic blink reflex and grimace

Studies have shown progressive worsening of OCT and to a lesser effect, VF and contrast sensitivity after a TBI.

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Original Investigation | Neurology

Association of Optical Coherence Tomography With Longitudinal Neurodegeneration in Veterans With Chronic Mild Traumatic Brain Injury

Casey S. Gilmore, PhD; Kelvin O. Lim, MD; Mona K. Garvin, PhD; Jui-Kai Wang, PhD; Johannes Ledolter, PhD; Alicia L. Fenske, BA; Carolyn L. Gentz, MA; Julie Nellis, RN, BSN; Michael T. Armstrong, MD; Randy H. Kardon, MD, PhD

Abstract

IMPORTANCE Mild traumatic brain injury (TBI) may predispose individuals to progressive neurodegeneration.

OBJECTIVE To identify evidence of neurodegeneration through longitudinal evaluation of changes in retinal layer thickness using optical coherence tomography in veterans with a history of mild TBI.

DESIGN, SETTING, AND PARTICIPANTS This longitudinal cohort study evaluated veterans who were receiving services at the Minneapolis Veterans Affairs Health Care System. Symptomatic or mild TBI was diagnosed according to the Mayo TBI Severity Classification System. Participants in the age-matched control group had no history of TBI. Participants with any history or evidence of retinal or optic nerve disease that could affect retinal thickness were excluded. Data analysis was performed from July 2019 to February 2020.

EXPOSURES The presence and severity of mild TBI were determined through consensus review of self-report responses during the Minnesota Blast Exposure Screening Tool semistructured interview.

MAIN OUTCOMES AND MEASURES Change over time of retinal nerve fiber layer (RNFL) thickness.

RESULTS A total of 139 veterans (117 men [84%]; mean [SD] age, 49.9 [11.1] years) were included in the study, 69 in the TBI group and 70 in the control group. Veterans with mild TBI showed

Key Points

Question Do veterans with a history of mild traumatic brain injury show greater neurodegeneration over time compared with control veterans with no history of head injury?

Findings In this longitudinal cohort study of 139 veterans with and without a history of mild traumatic brain injury, mild traumatic brain injury was associated with significantly greater thinning of the retinal nerve fiber layer over time.

Meaning These findings suggest that structural neural loss in the visual system, as evidenced by thinning of the retinal nerve fiber layer, may be a useful biomarker of neurodegeneration following chronic mild traumatic brain injury.

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The results of visual and cognitive functional tests also showed evidence for progressive loss, but to a lesser degree than structural loss, and only in some of the behavioral functions tested. Some

(Visual field and contrast sensitivity)

Original Investigation | Neurology

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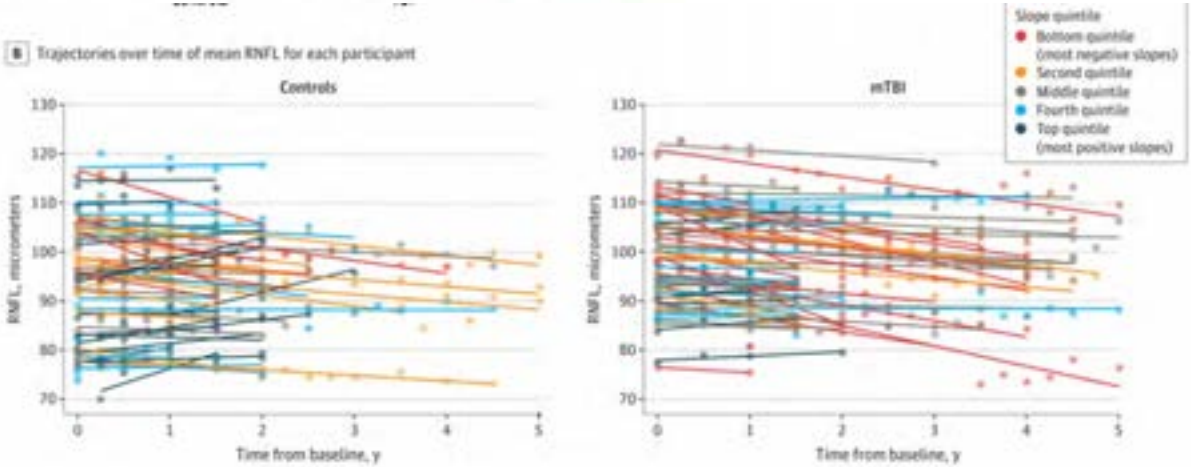
CONCLUSIONS AND RELEVANCE This cohort study found longitudinal evidence for significant, progressive neural degeneration over time in veterans with mild TBI, as indicated by greater RNFL tissue loss in patients with mild TBI vs controls, as well as measures of function. These results suggest that these longitudinal measures may be useful biomarkers of neurodegeneration. Changes in this biomarker may provide early detection of subsequent cognitive and functional deficits that may impact veterans' independence and need for care.

JAMA Network Open. 2020;3(12):e2030824. doi:10.1001/jamanetworkopen.2020.30824

Progressive loss of retinal neurons by OCT occurs years after mTBI in veterans.



A, Graph shows mean slope of averaged eyes RNFL (micrometers per year; dark dots with SE bars). Light dots show data for individuals in the mild traumatic brain injury (mTBI) and control groups. Groups significantly differed (mean [SE] RNFL slope, −1.47 [0.24] µm/y vs −0.31 [0.32] µm/y; $F_{1,122} = 8.42$; $P = .004$, Cohen $d = 0.52$). B, Graphs show trajectories of RNFL thickness over time for individual participants in mTBI and control groups; dots are time points and lines are linear fit lines for each participant. Colors represent the RNFL slopes grouped by quintiles: bottom quintile contains the most negative slopes, top quintile contains the most positive slopes.

- Those with a history of TBI, including mild TBI (mTBI), are at greater risk for neurodegenerative diseases, such as Alzheimer's Disease (AD), Parkinson's Disease (PD), and Chronic Traumatic Encephalopathy (CTE), even in individuals with no known cognitive impairments after TBI.

- It is suspected that mTBI may initiate a process of persistent neuroinflammation and long-term gray and white matter atrophy leading to progressive neural degeneration over time.

CHRONIC TRAUMATIC ENCEPHALOPATHY (CTE)

- **Repeated concussions** can cause cumulative neuropsychologic deficits
  - Cognitive impairment
  - Change in behavior and personality
  - Depression
  - Suicidality
  - Parkinsonism
  - Other speech and gait abnormalities

Documented in athletes (boxers, football players) and military personnel (blast injuries).

Seen in 110/111 deceased NFL players
JAMA. 2017;318(4):360.

But, CTE has been proven to have occurred after just 1 concussion!

SALUS UNIVERSITY

SECOND IMPACT SYNDROME

- Suffering a second traumatic brain injury in close time proximity to a primary brain injury
- Exacerbates neuronal injury in cells made vulnerable by the initial TBI
- Diffuse cerebral swelling develops in the setting of a second concussion, which has occurred when a patient is still symptomatic from an earlier concussion.
- Disordered cerebral autoregulation causing cerebrovascular congestion and malignant cerebral edema with increased intracranial pressure
- Rare, but potentially FATAL

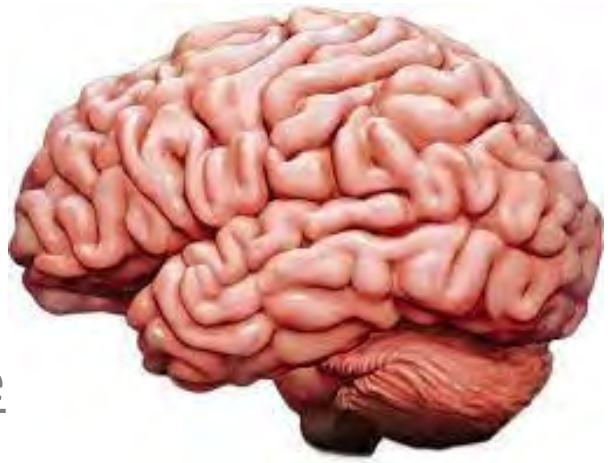
This is why it is so important for an athlete to be immediately removed from play after head trauma!

Athletes will hide symptoms to try to stay in the game.

Tumor Background Information

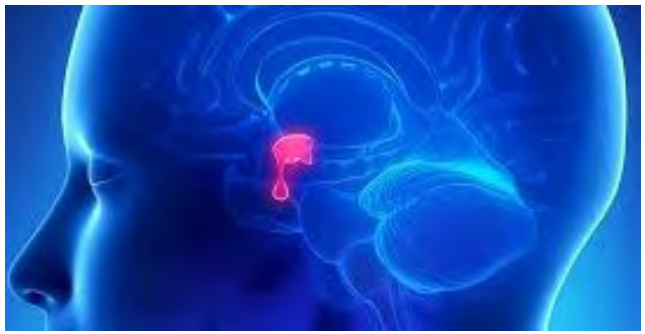
Tumors Associated with CNS Insult

- Primary Tumors Affecting Brain Tissue
  - Benign
  - Malignant



- Secondary Tumors Affecting Brain Tissue
  - Metastasis to Brain Tissue
  - Metastasis to Bones of Skull
  - Metastasis to CSF

- Tumors of Glands
  - Benign = Adenoma
  - Malignant = Adenocarcinoma



Basic Types of Primary Cancers

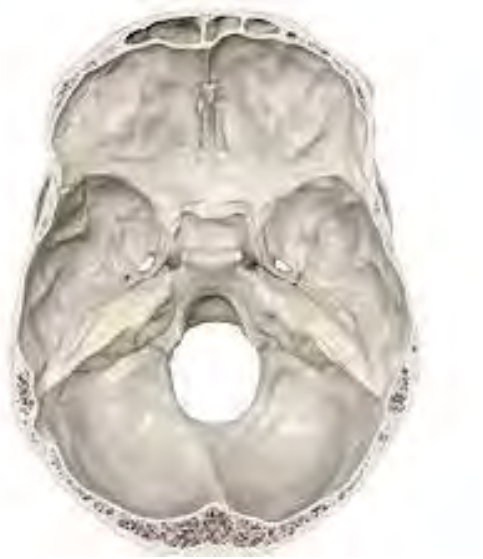
- *Carcinoma* – cancers that are epithelial in origin
  - Lung, Breast, Colon, Prostate, etc. (Often these present as metastatic cancers)
- *Sarcoma* - any cancer of connective tissue or supportive tissue
  - Bone, cartilage, fat, muscle
- *Glioma* – originates in brain or spine tissue
  - Astrocytoma, Oligodendroglioma, Ependymoma
- *Meningiomas* – arise from meninges
  - Atypical, Anaplastic
- *Schwannomas* – nerve sheath / Schwann cells (acoustic neuroma)
- *Medulloblastomas*– a form of primitive neuroectodermal tumor (PNET) in the cerebellum / posterior fossa
- *Hematologic Malignancies* – blood, bone marrow & lymph nodes
  - Leukemia, Lymphoma, Myeloma

BRAIN METASTASES

- among the most common mass lesions in brain
- increased incidence traced to an increase in the median survival of patients with cancer
  - modern therapies, increased availability of advanced imaging techniques for early detection, and vigilant surveillance protocols for monitoring recurrence
  - most systemic treatments (eg, the use of chemotherapeutic agents, which may penetrate the brain poorly) can transiently weaken the blood-brain barrier (BBB) and allow systemic disease to be seeded in the CNS, leaving the brain a safe haven for tumor growth

BONE METASTASES

- Primary bone cancers are rare
- Associated with lytic lesions and pain

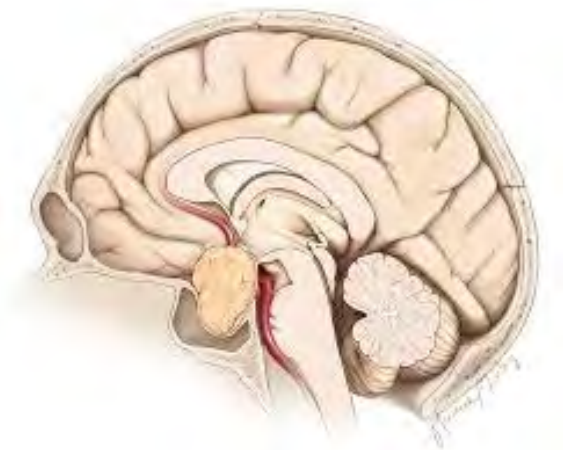


- Sites of Origin
  - Prostate
  - Breast
  - Lung

- Sites of metastases (to cause neuro-ophthalmic disorder)
  - Clivus
  - Skull base

PITUITARY ADENOMA

- Most common intracranial tumor that optometrists will encounter
- Main concern of mass effect is vision loss
  - Proximity to optic chiasm
- Can be functional or non-functional
  - Endocrine abnormalities
- Can become apopletic
  - Sudden infarct / bleeding
  - Medical emergency



https://www.aaroncohen-gadol.com/patients/pituitary-tumor/treatment/surgery

CASE 2
Tumor

History and Examination

- 41 yo male
- CC: “is noticing that his vision is blurry and gets worse when he has sugars. Is struggling with eye strain while working on the computer at work.”
- Pt. self-reported very low testosterone levels

History and Examination

Entering VA cc
OD 20/20++
OS 20/20

Pupils
OD: PERRLA (-)APD
OS: PERRLA (-)APD

EOMS
OD: full & smooth
OS: full & smooth

Confrontation Fields
OD: temporal restriction
OS: temporal restriction

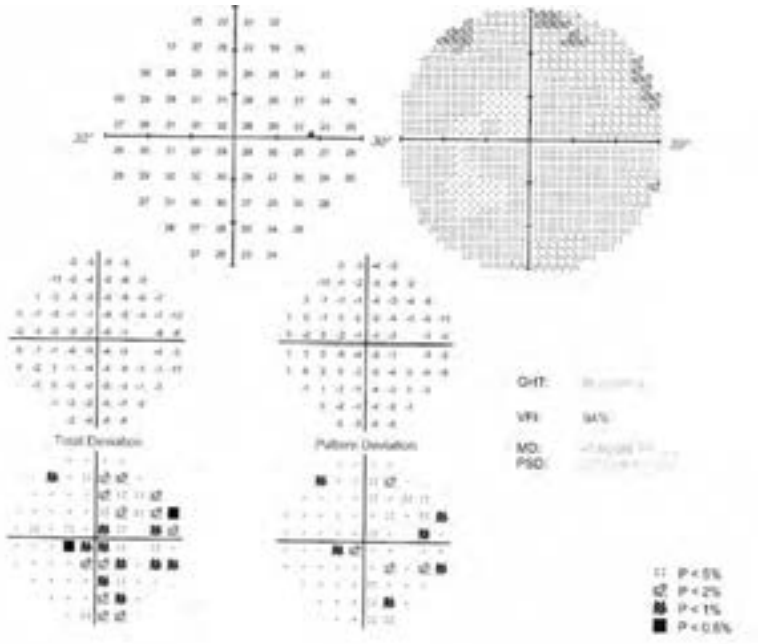
History and Examination

IOP
OD: 10 mmHg
OS: 10 mmHg

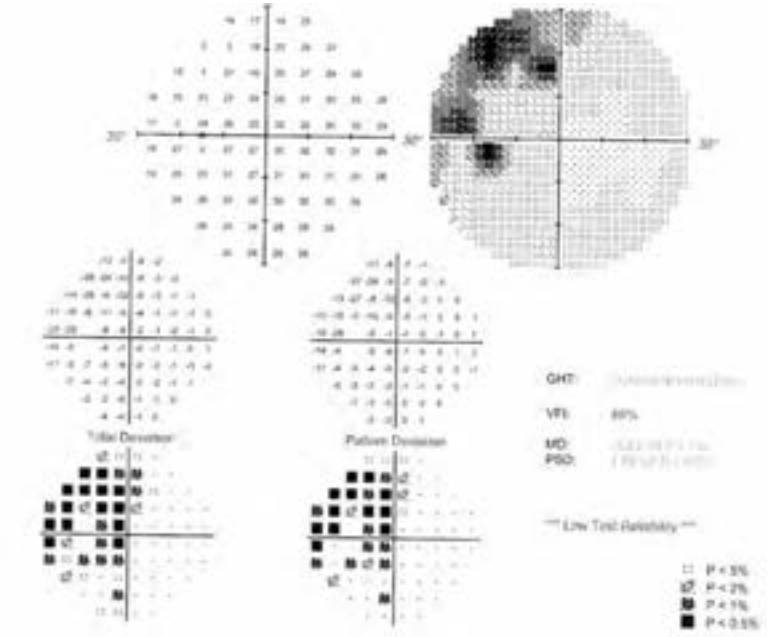
Anterior segment
OD: wnl
OS: wnl

Posterior segment
OD: wnl
OS: wnl

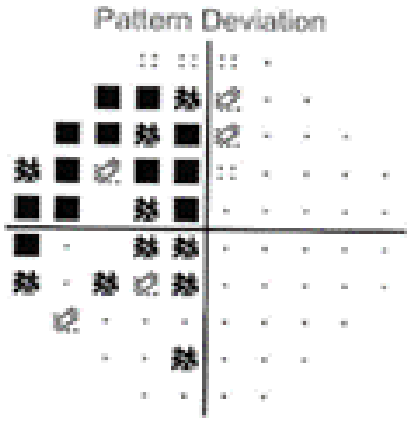
OD 30-2

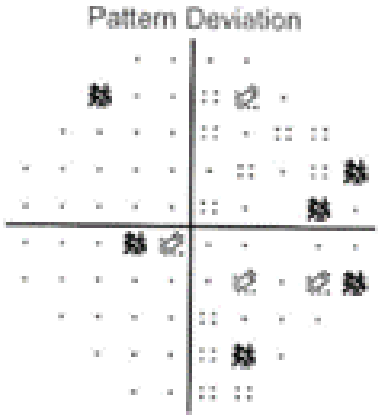


OS 30-2



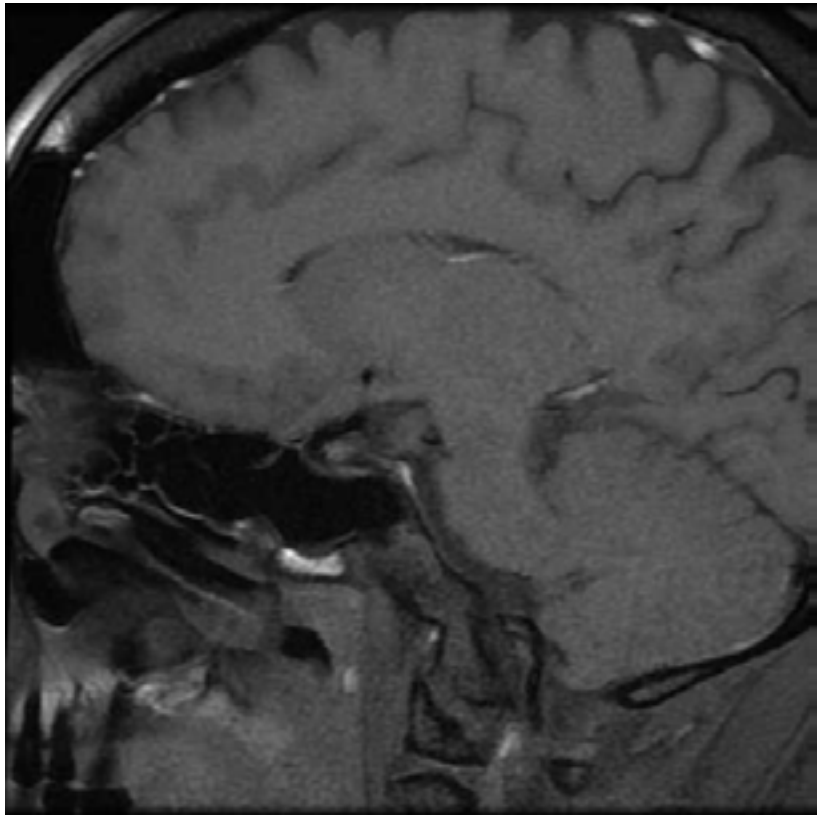
30-2 OS and OD

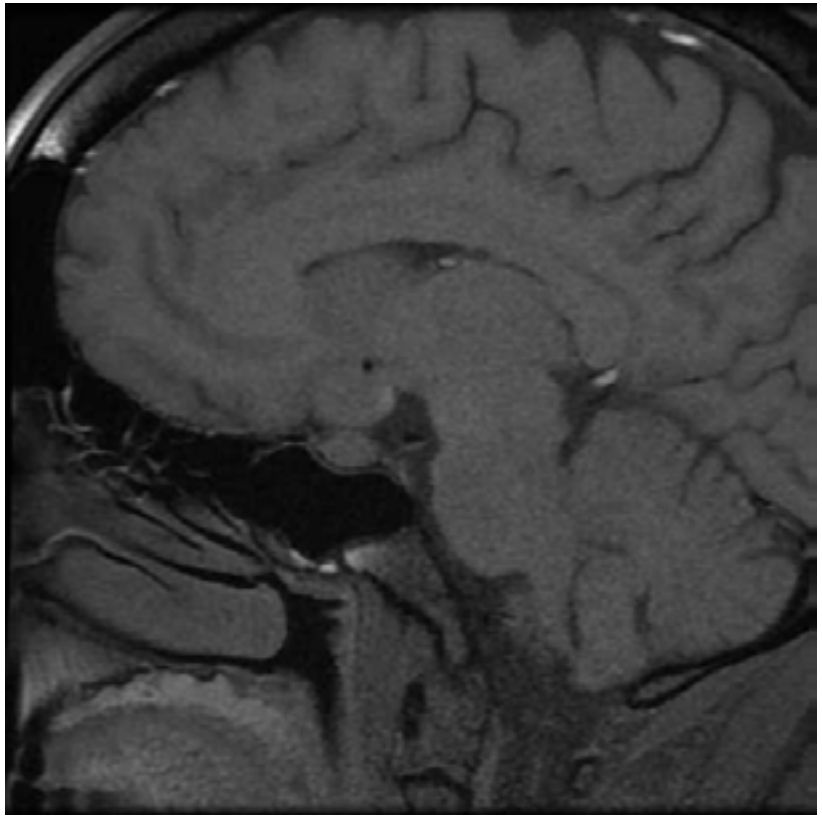


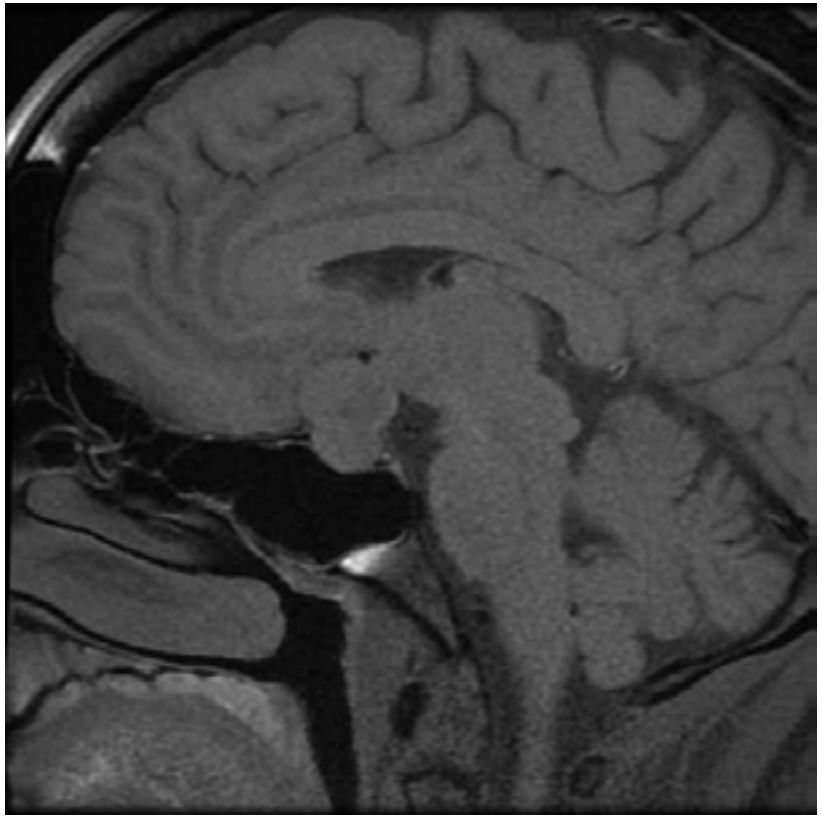


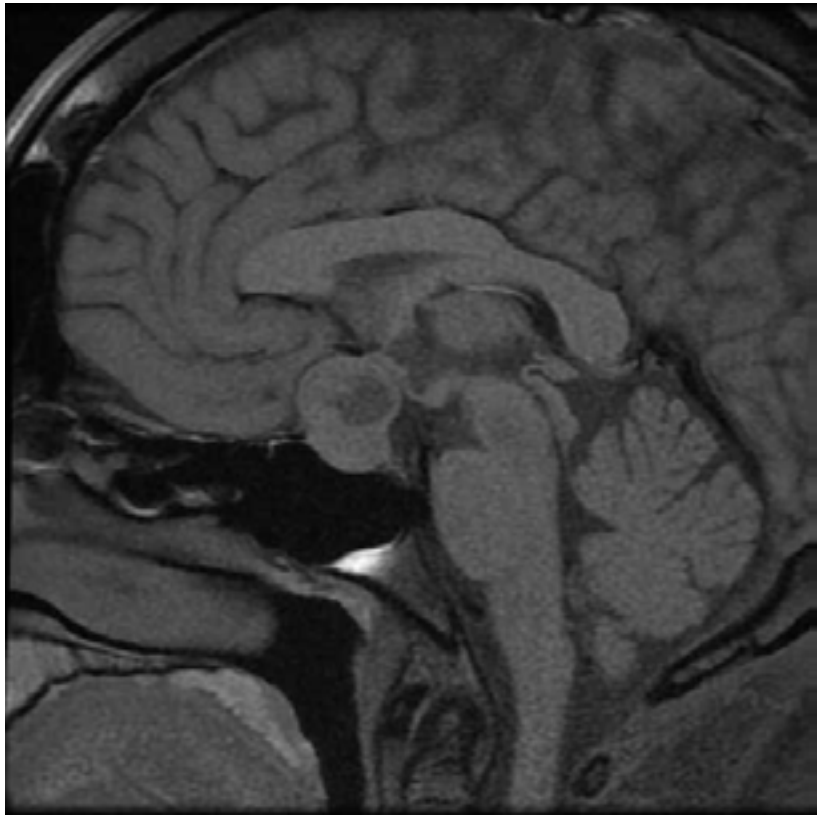
T1 Sequence w/o Contrast

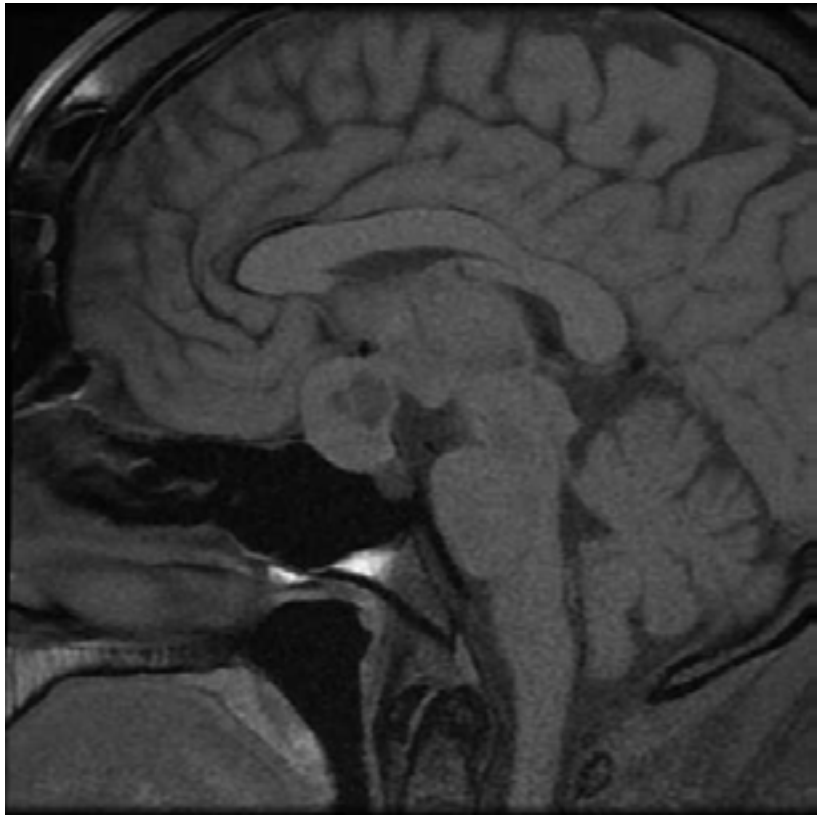
Sagittal

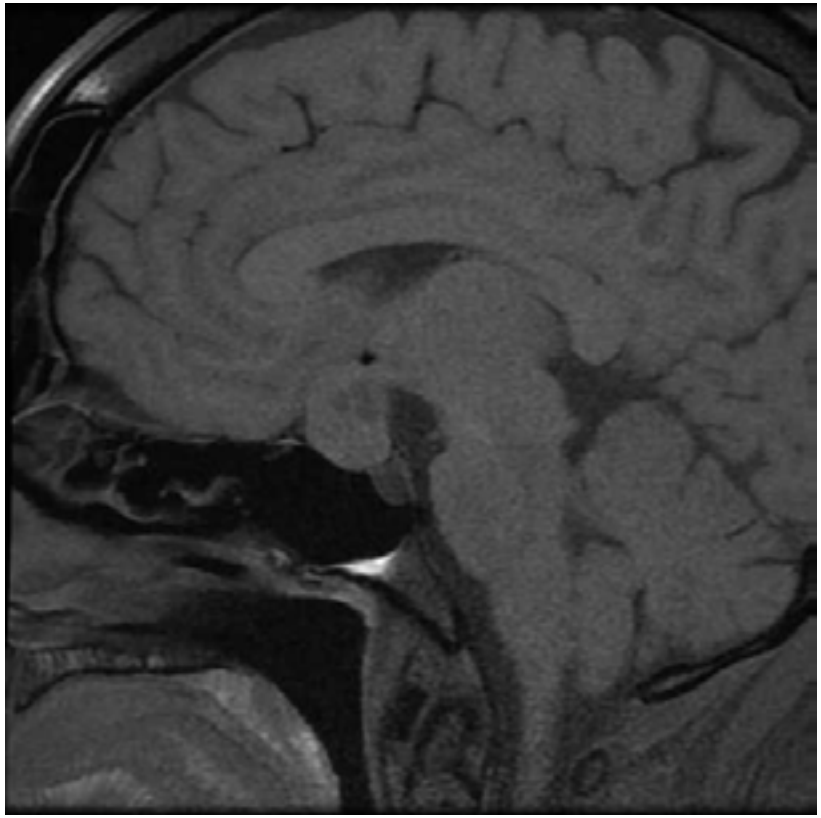


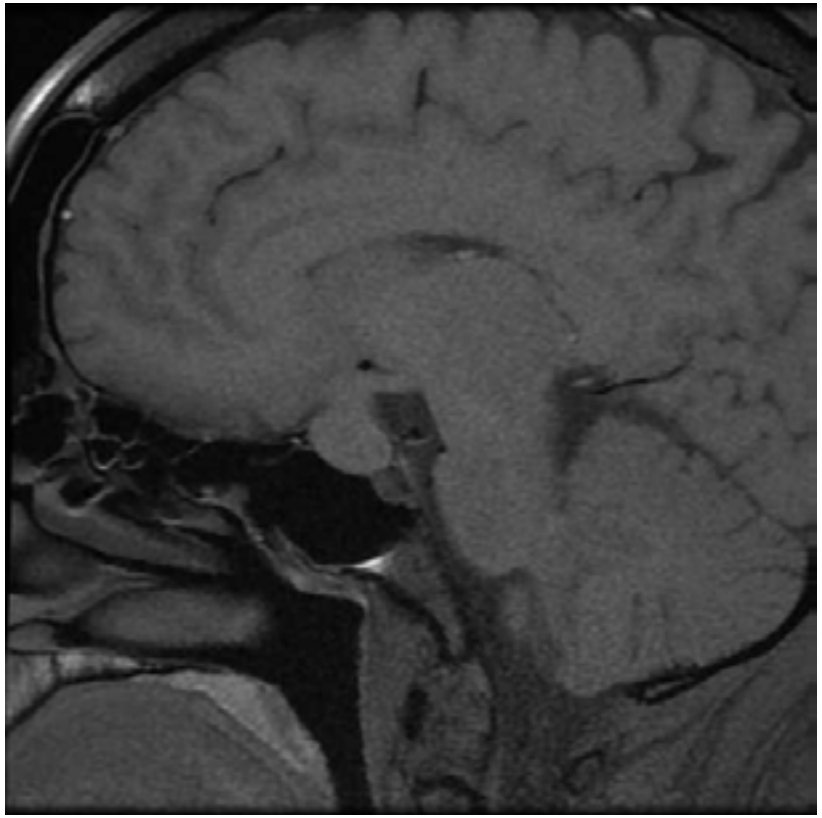


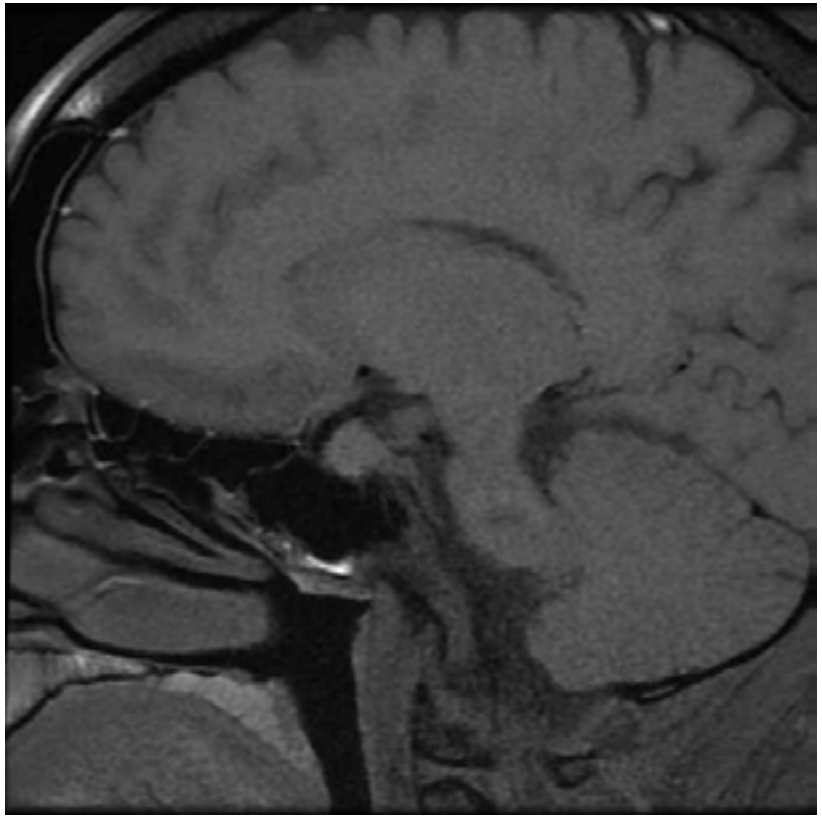


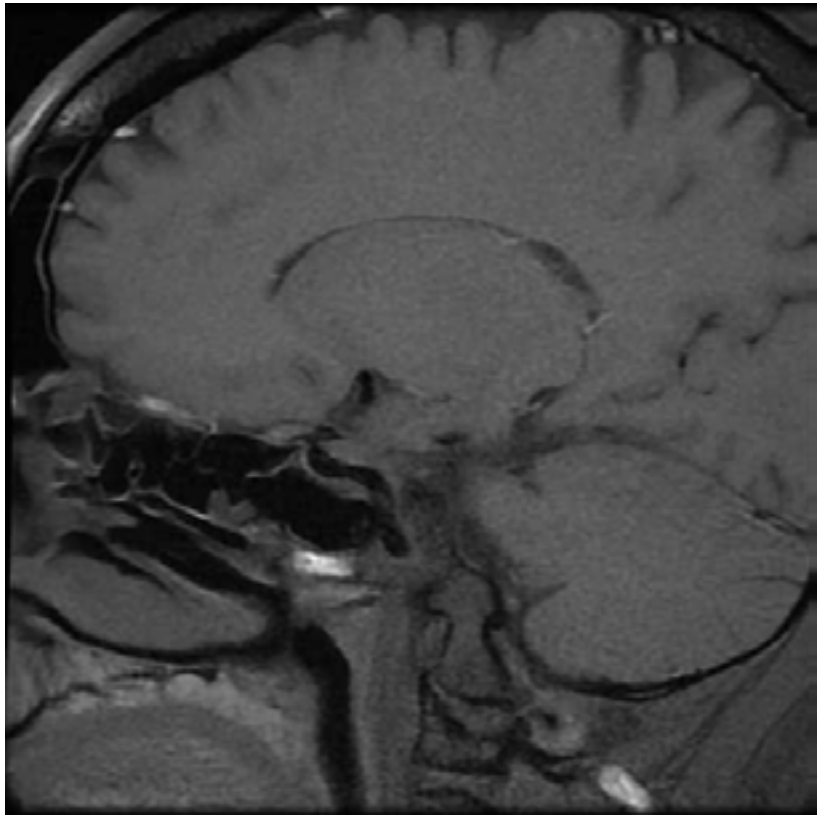






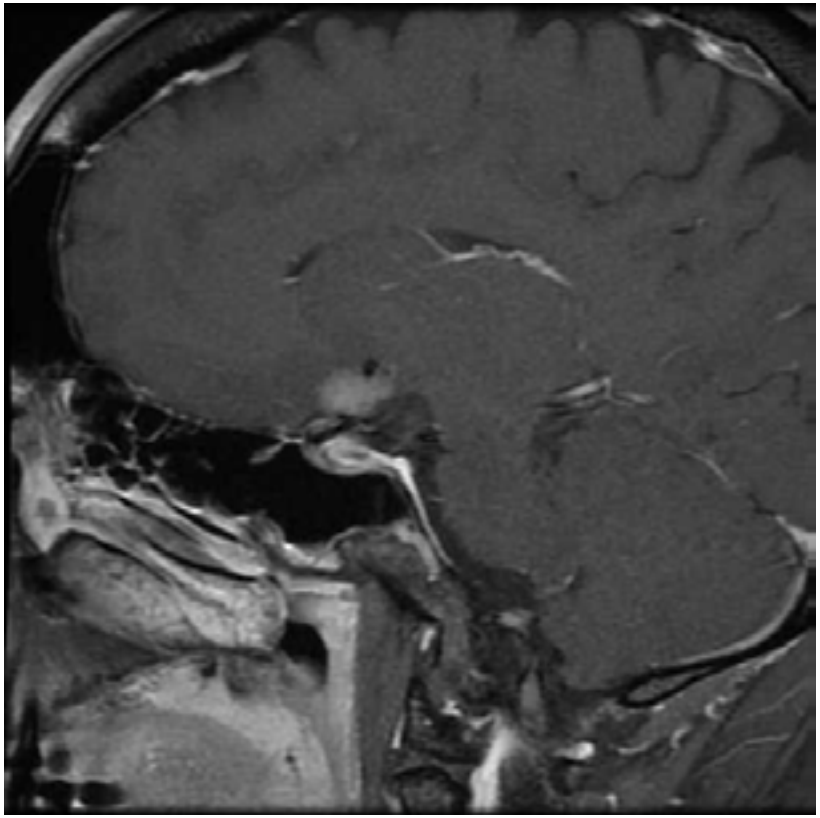


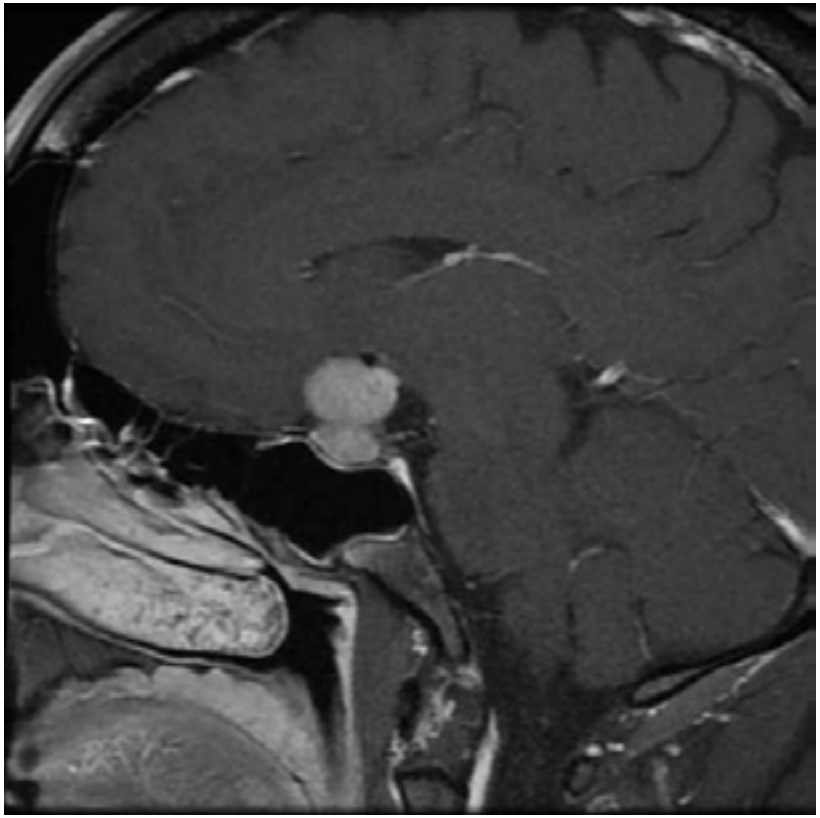


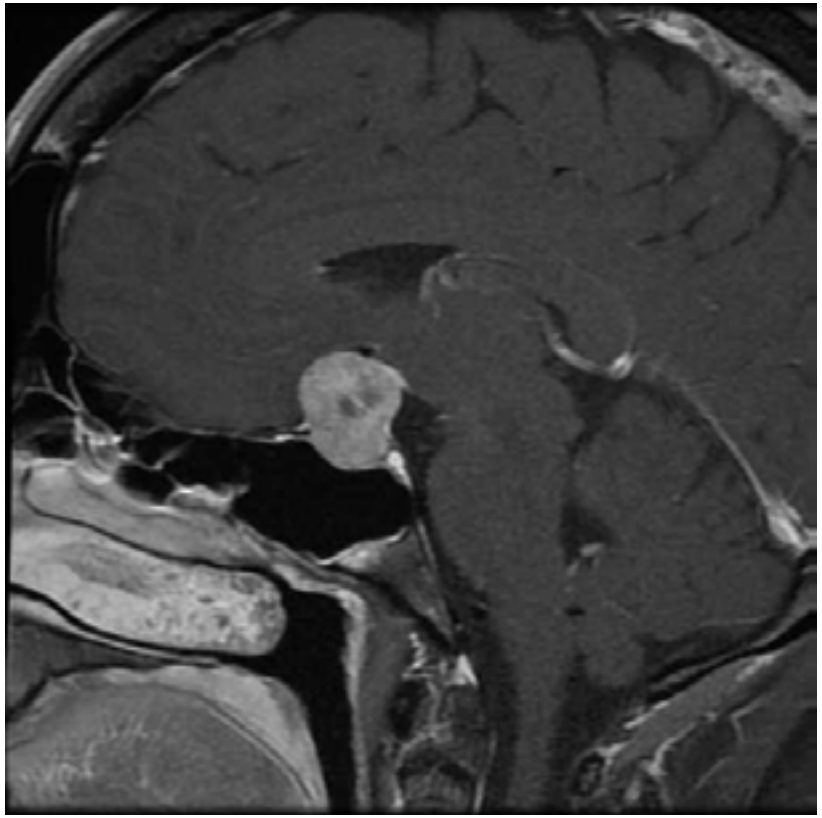


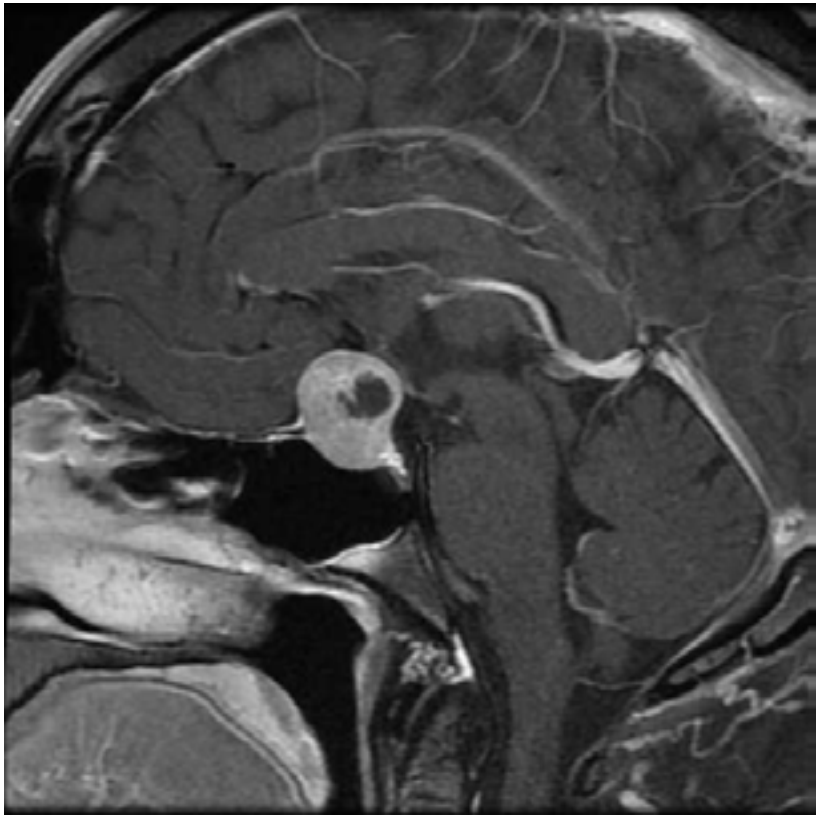
T1 Sequence w/ Contrast

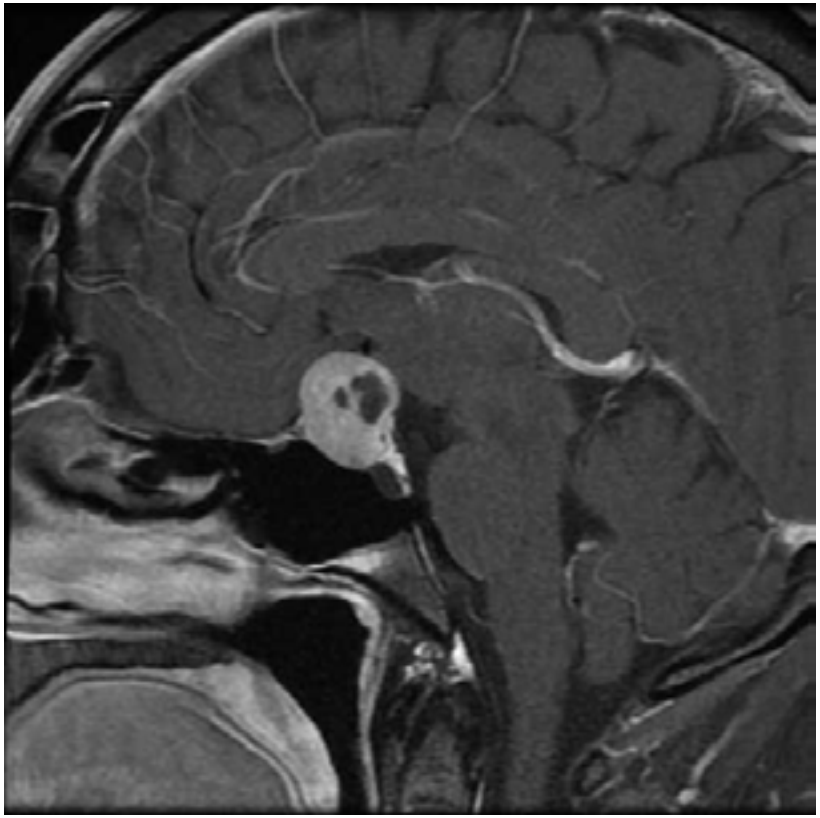
Sagittal

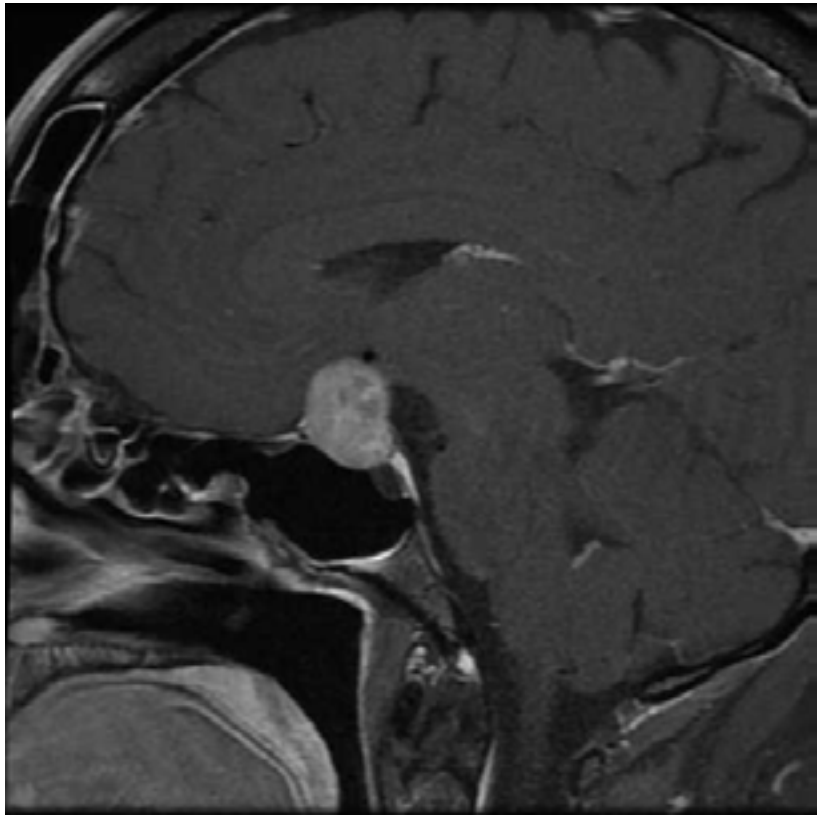


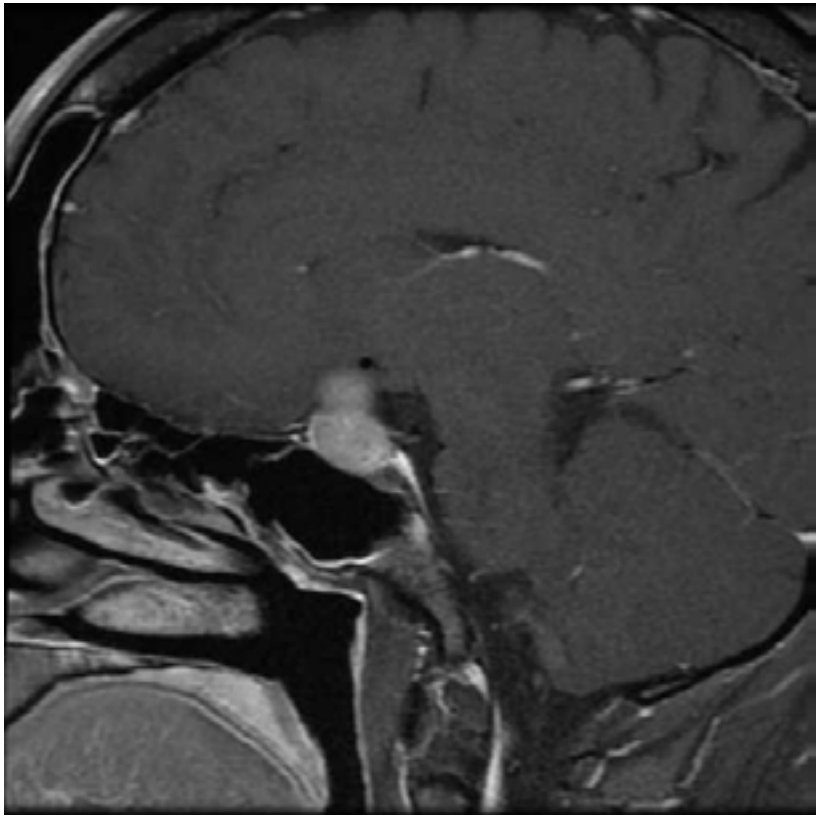


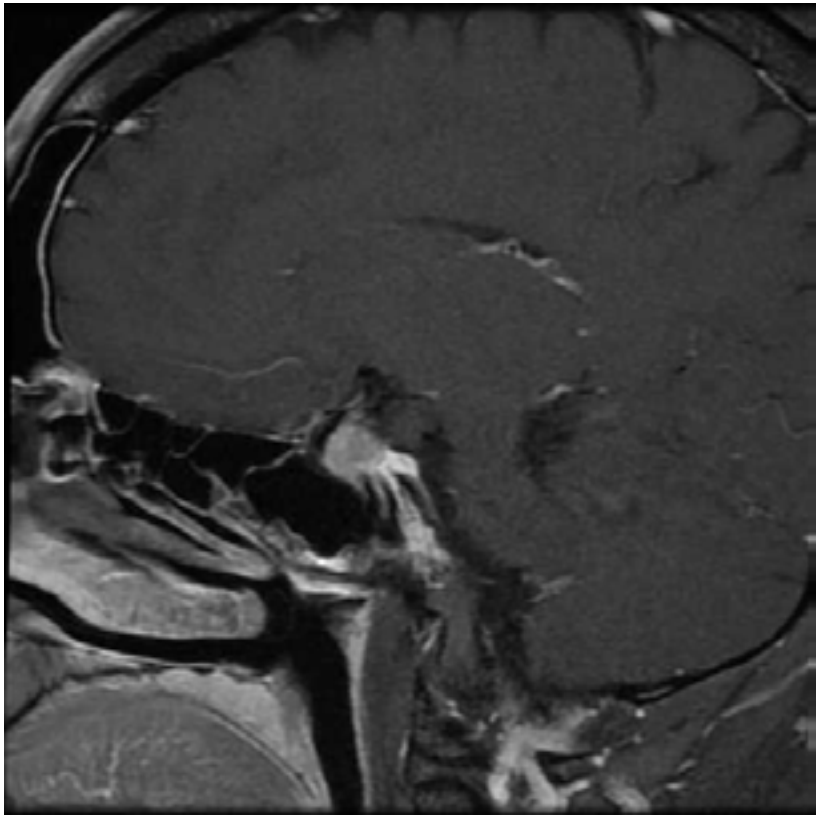


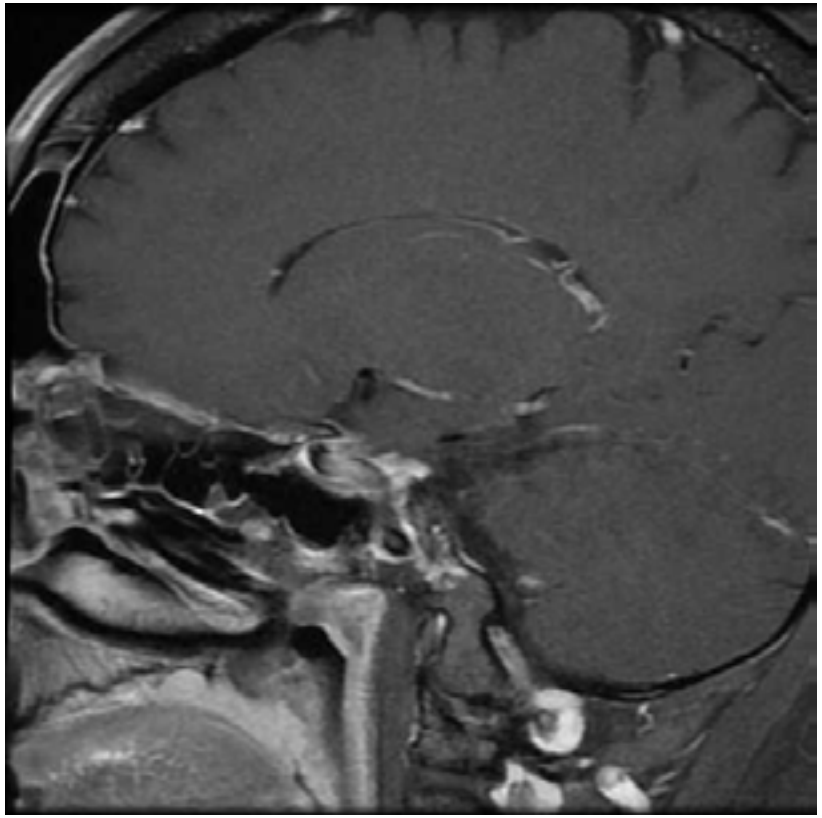




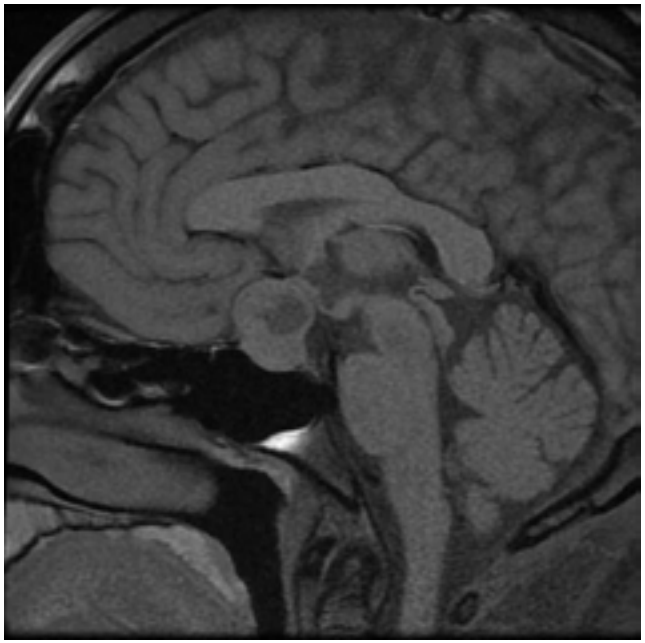


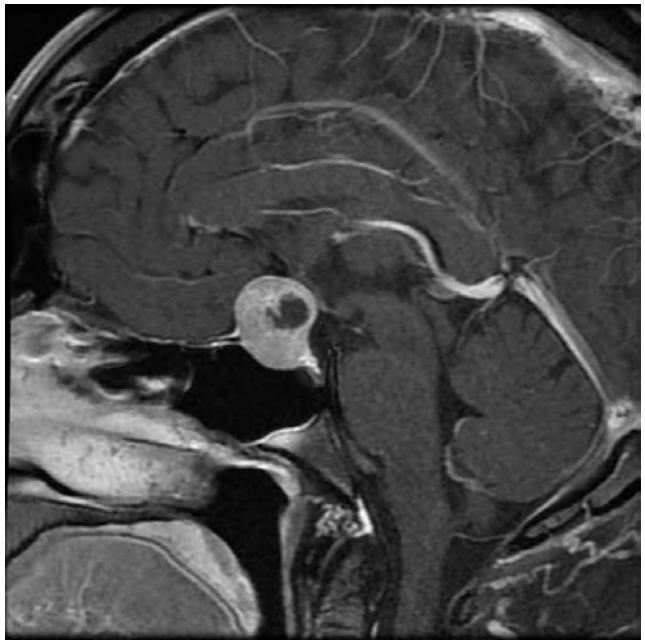






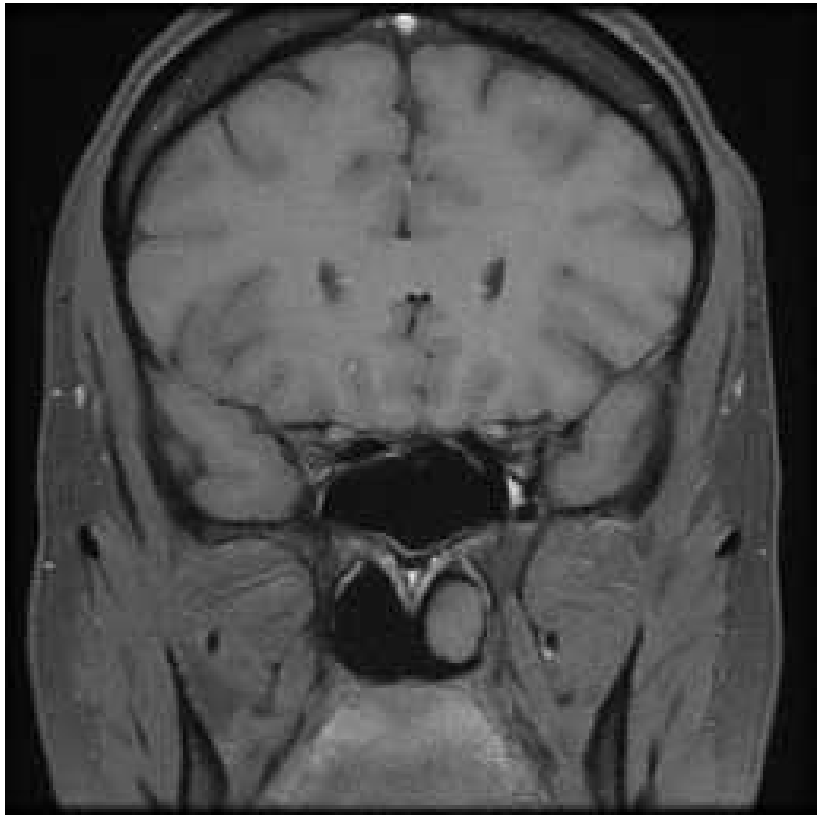
Contrast vs. No Contrast

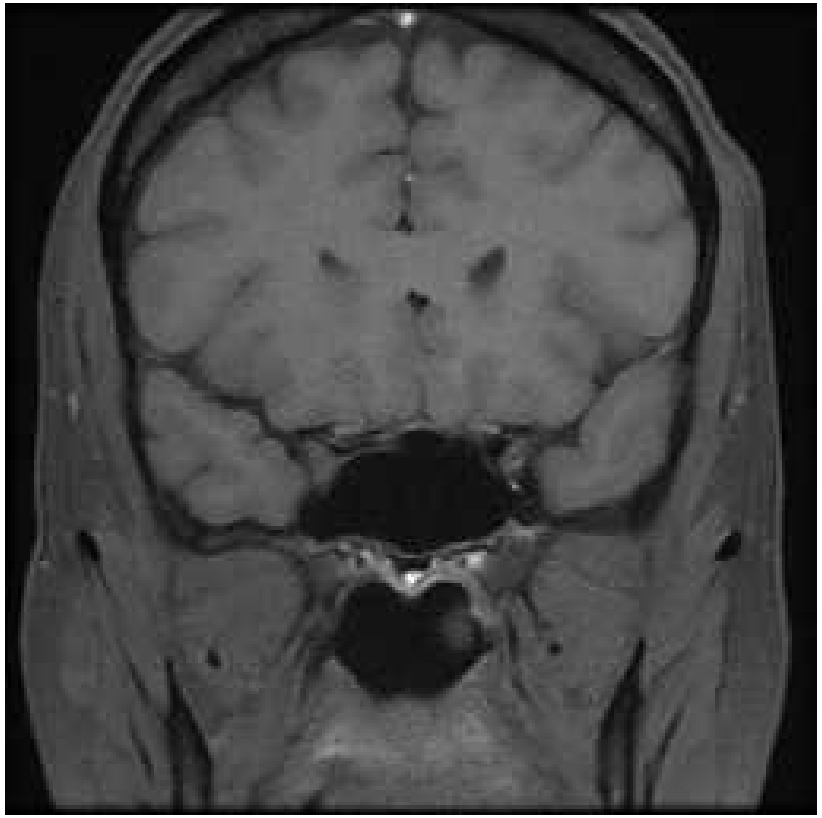


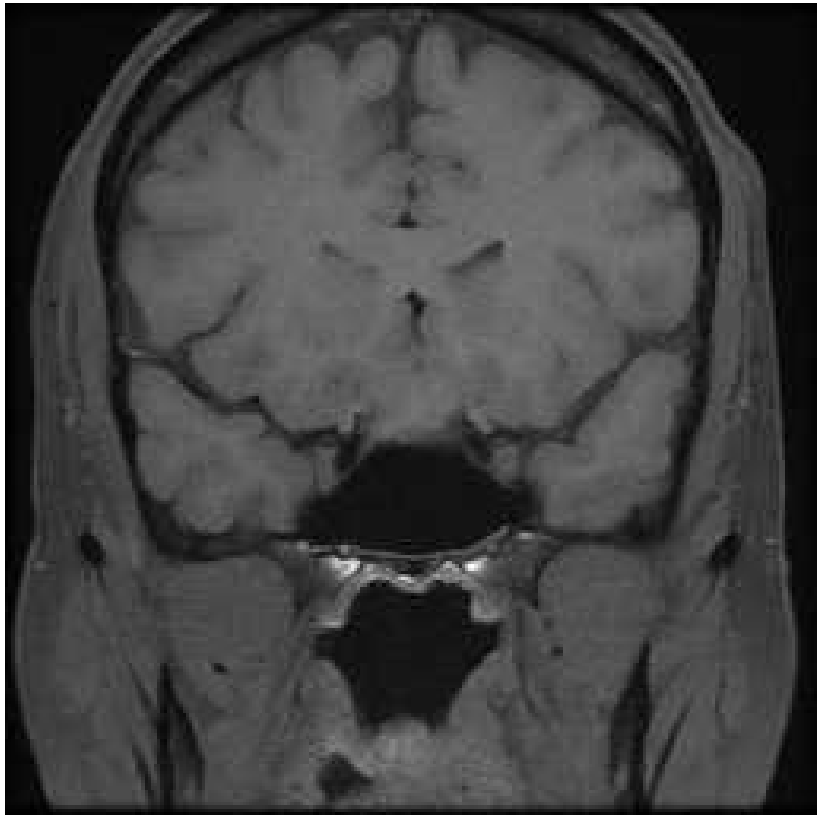


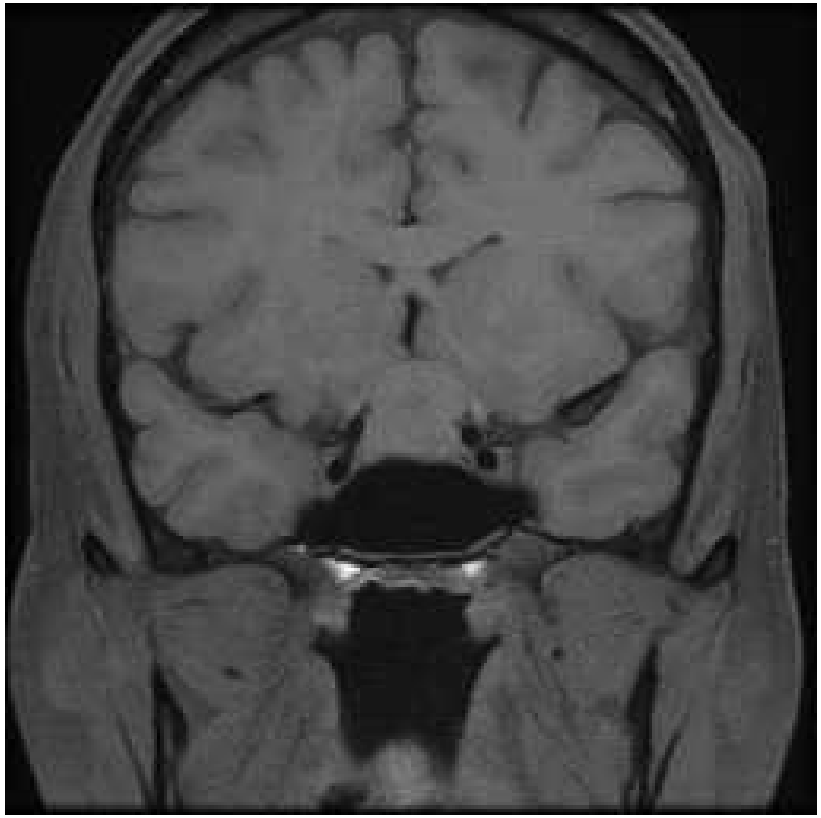
T1 Sequence w/o Contrast

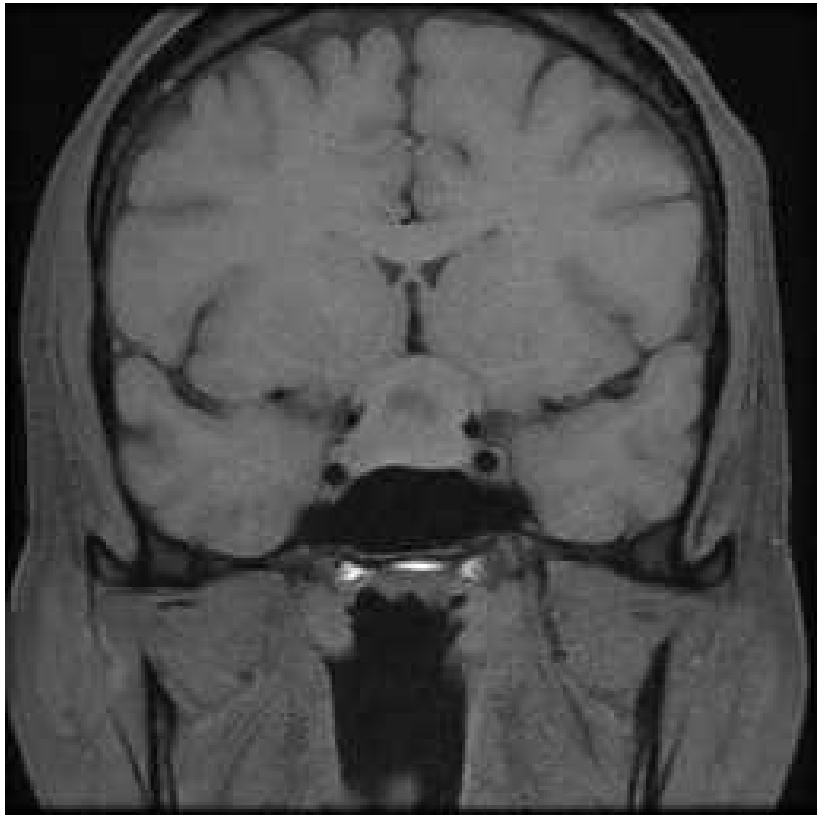
Coronal

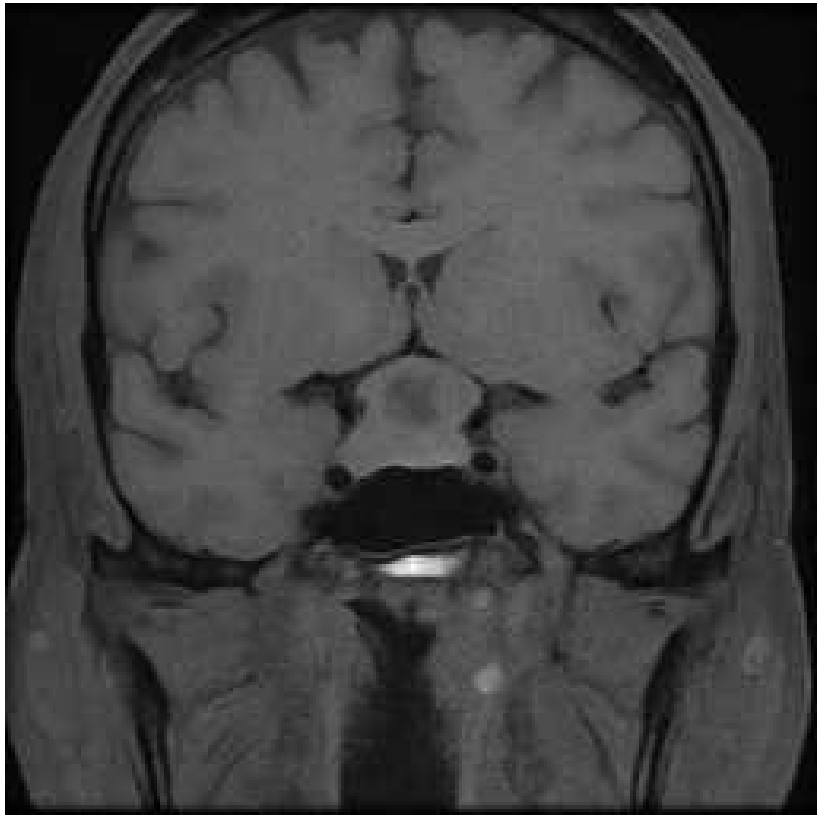


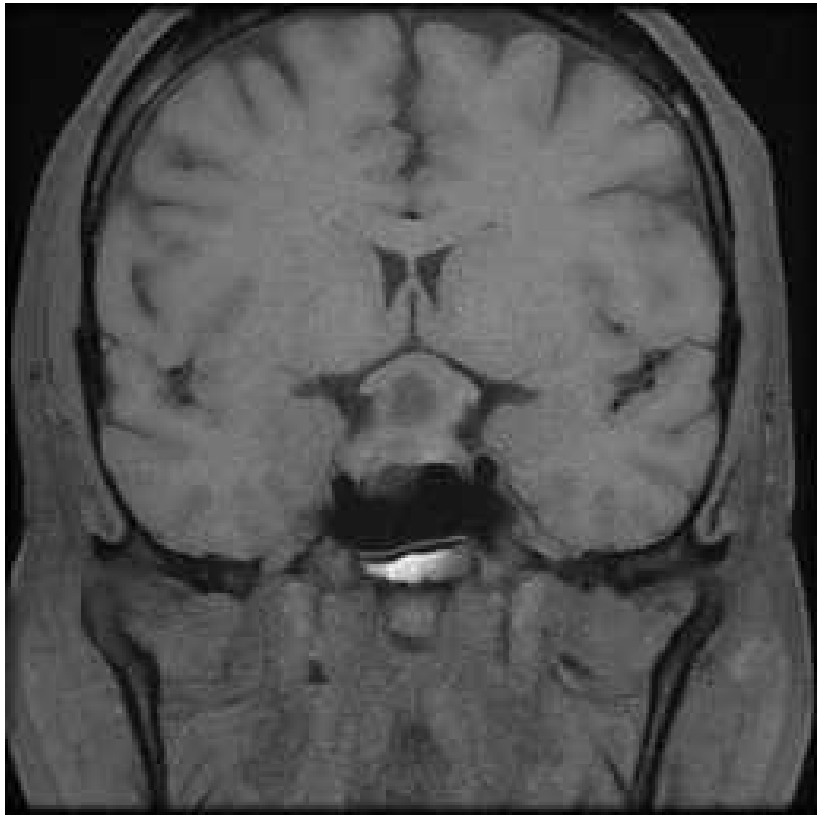


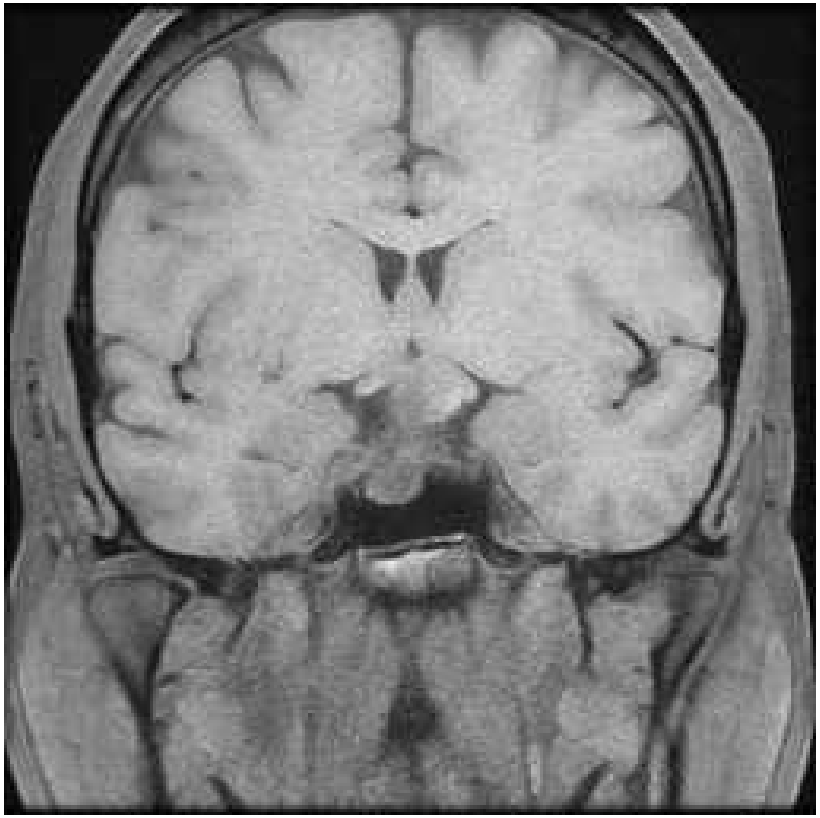


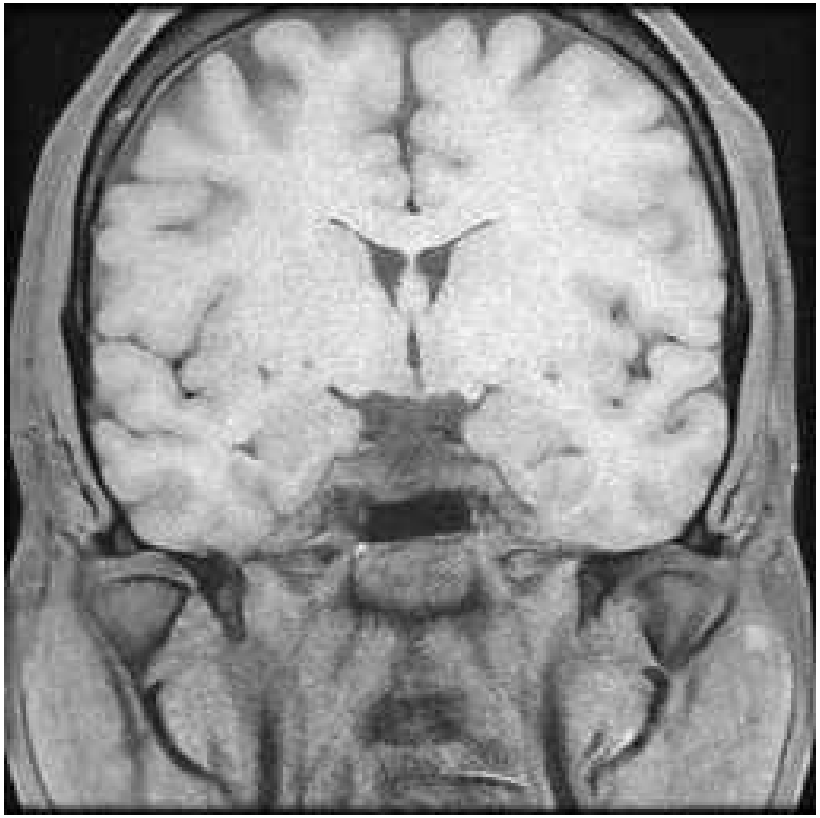


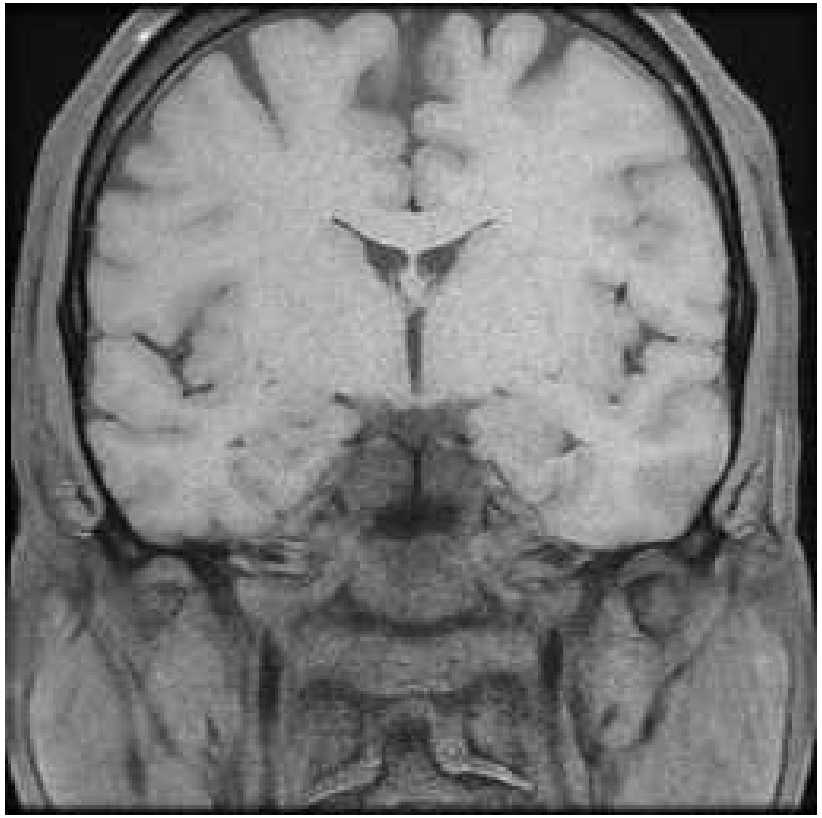


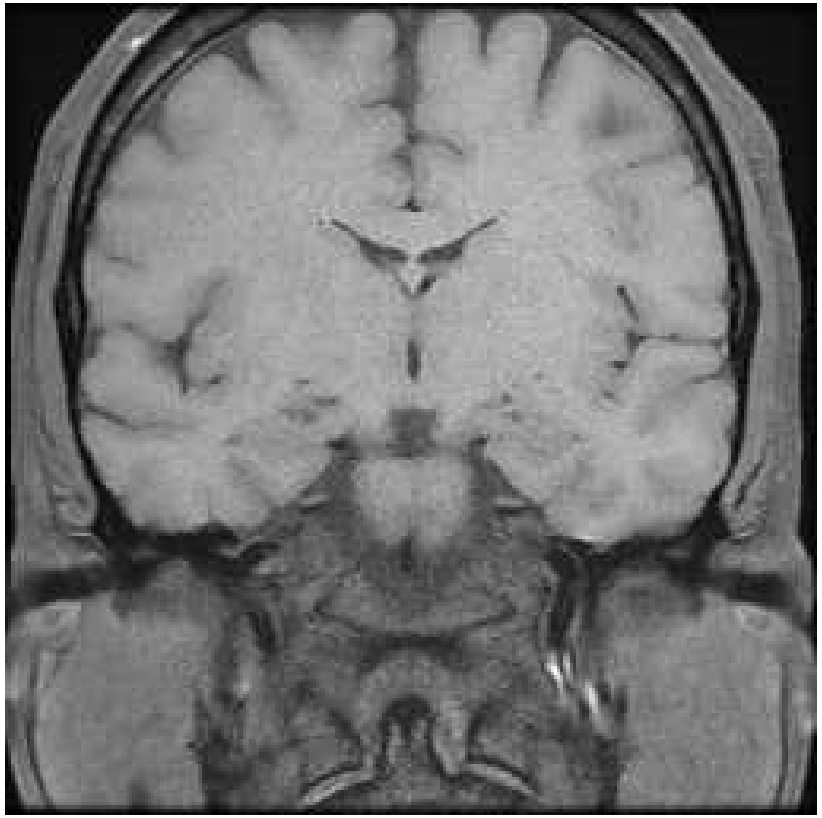


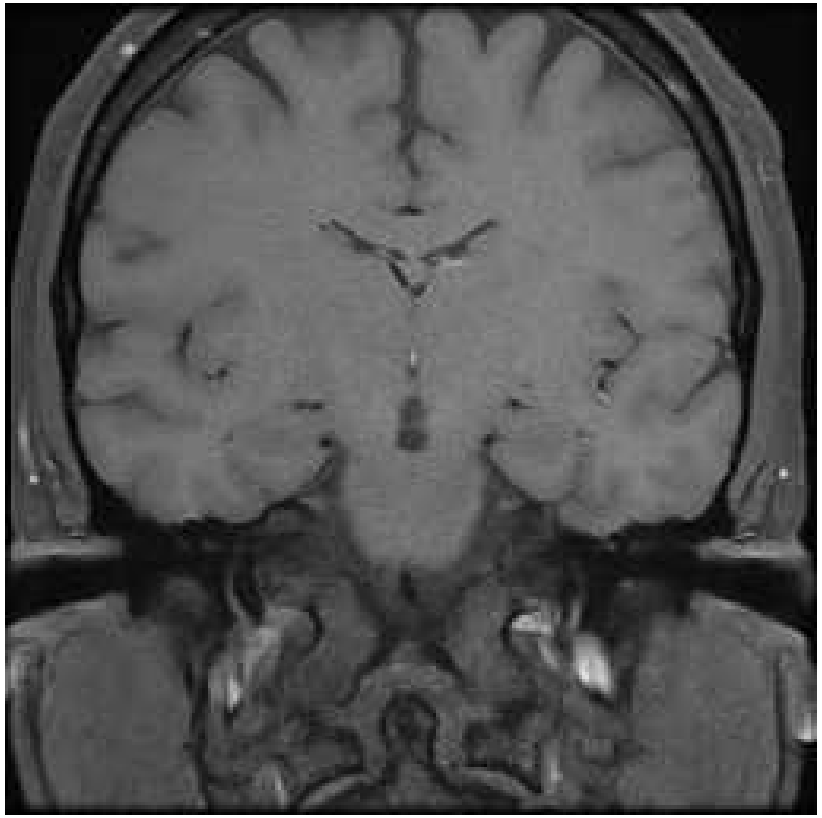






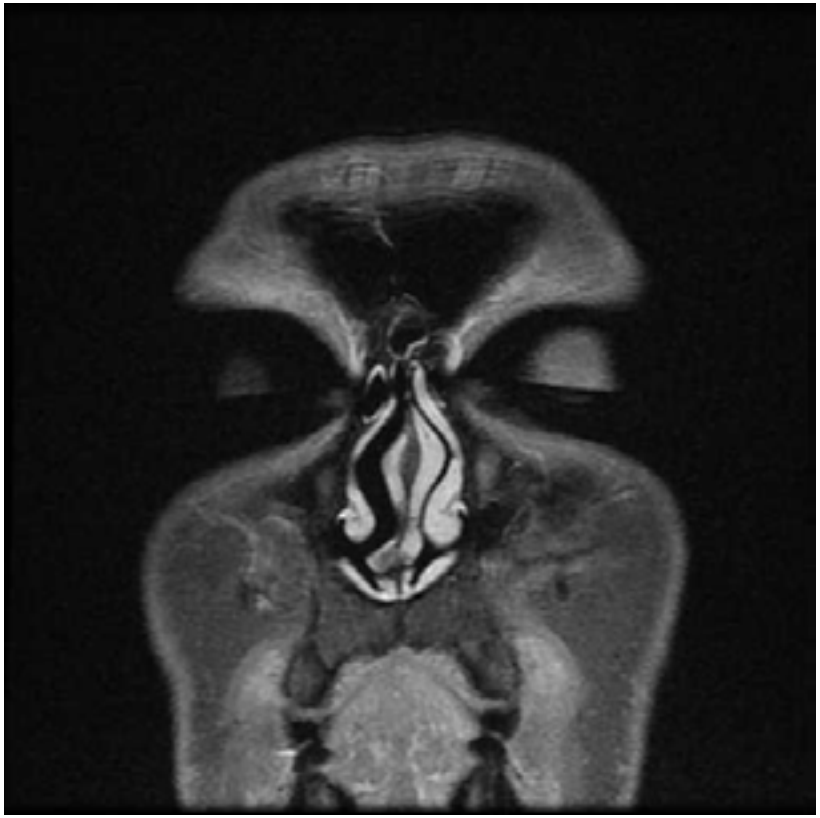


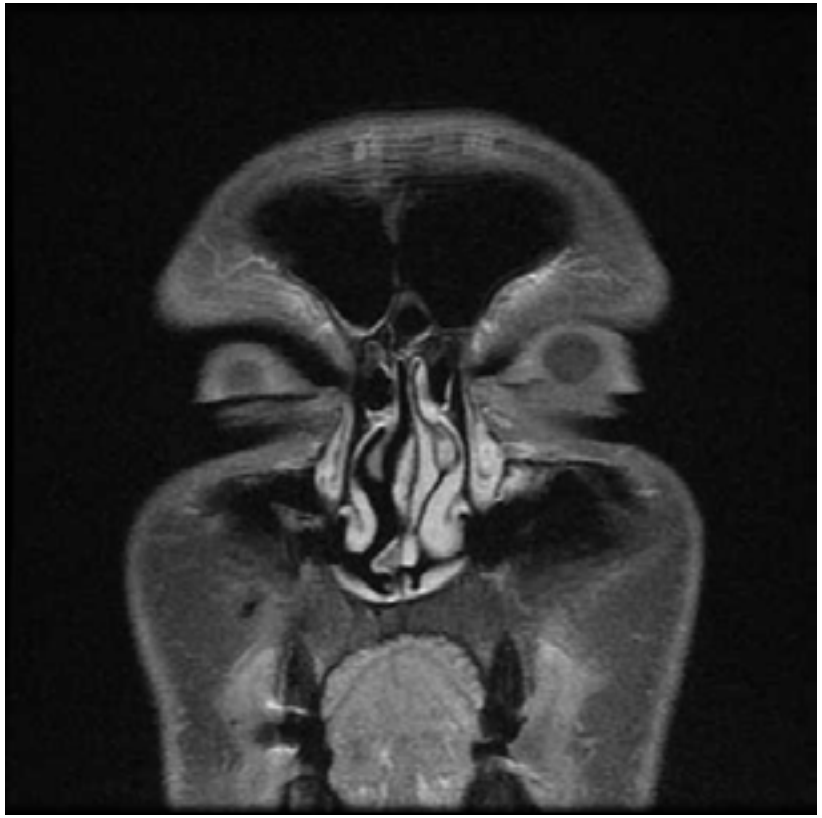


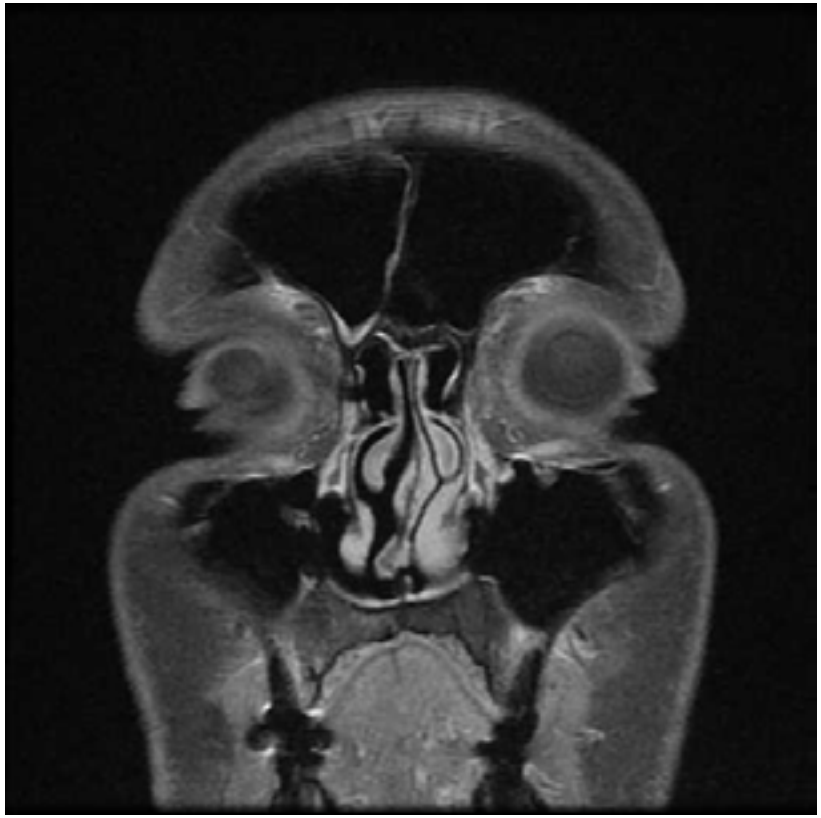


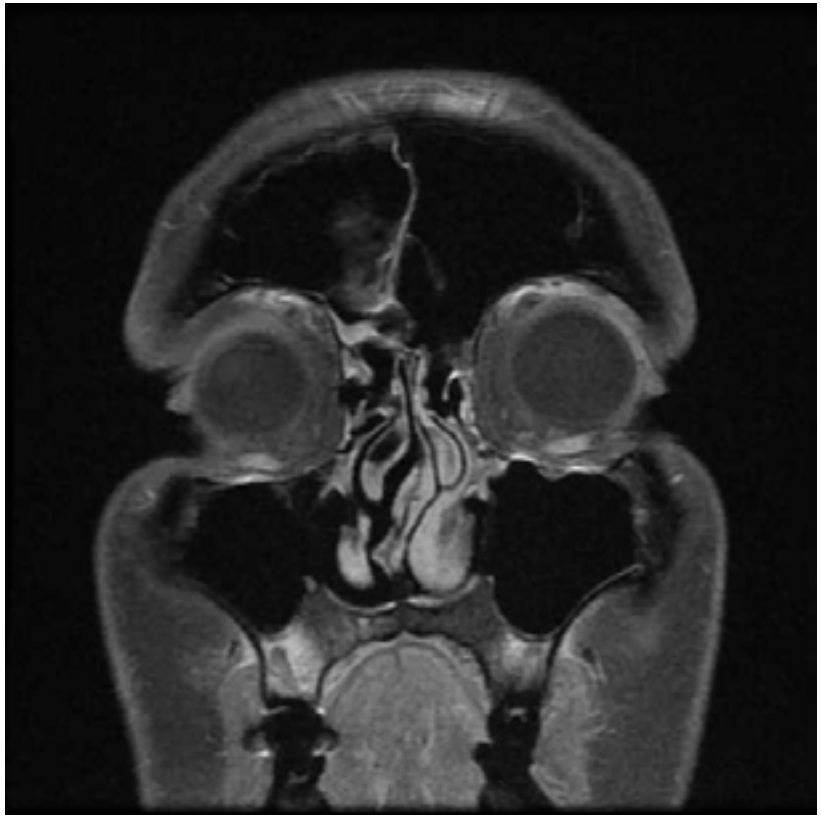
T1 Sequence w/ Contrast

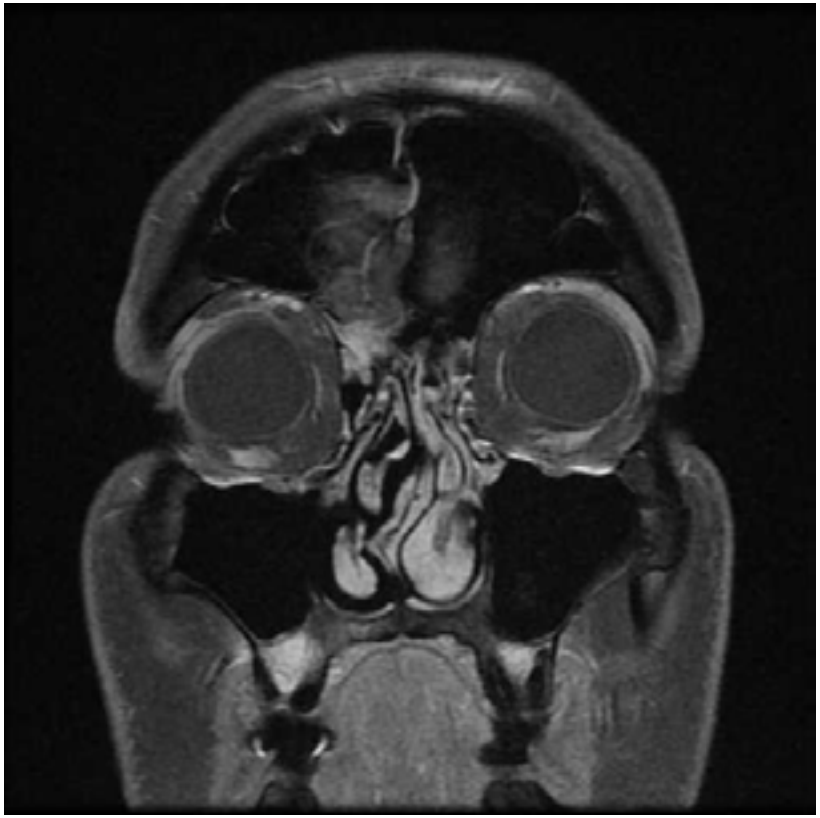
Coronal

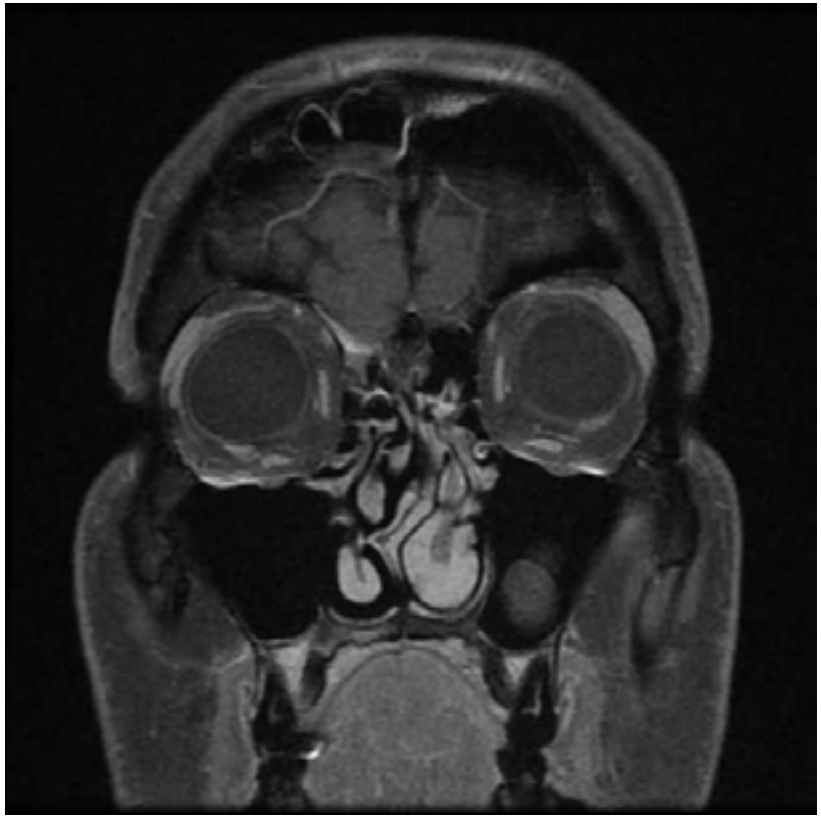


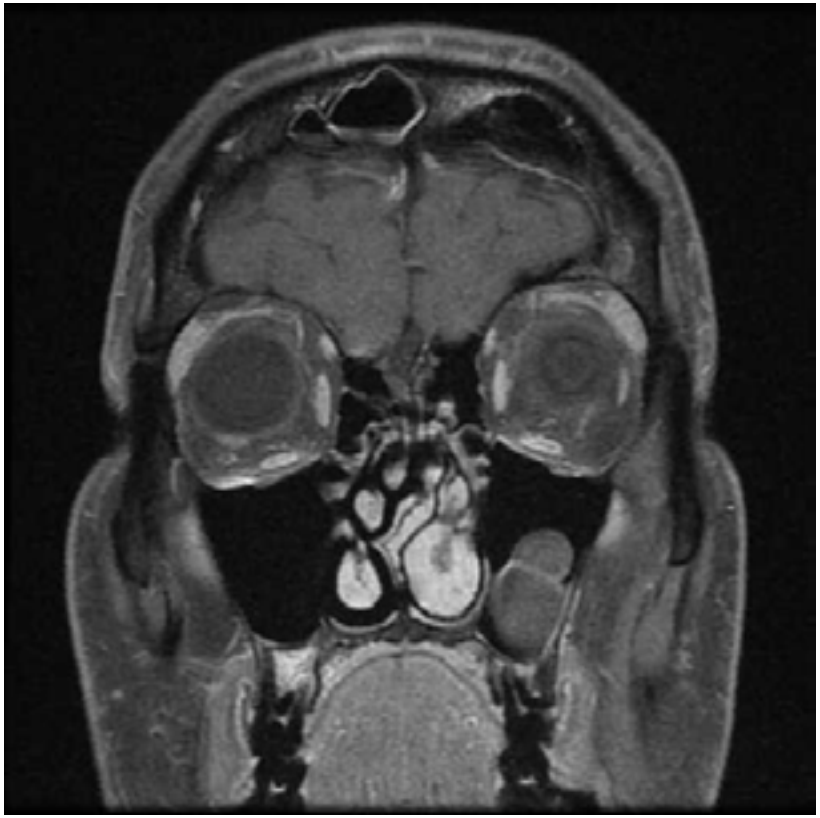


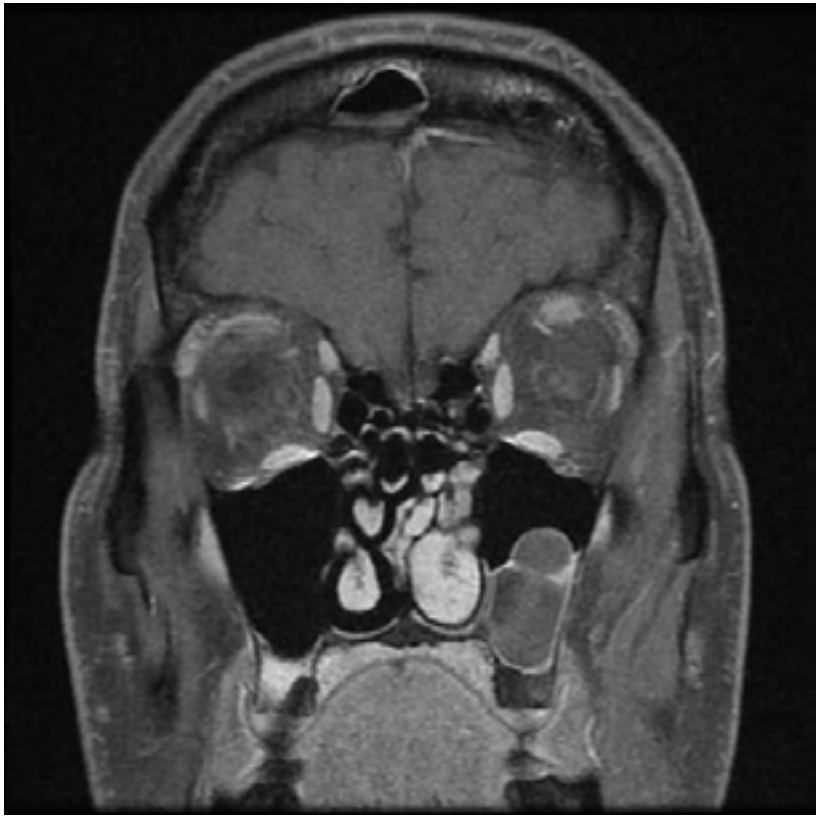


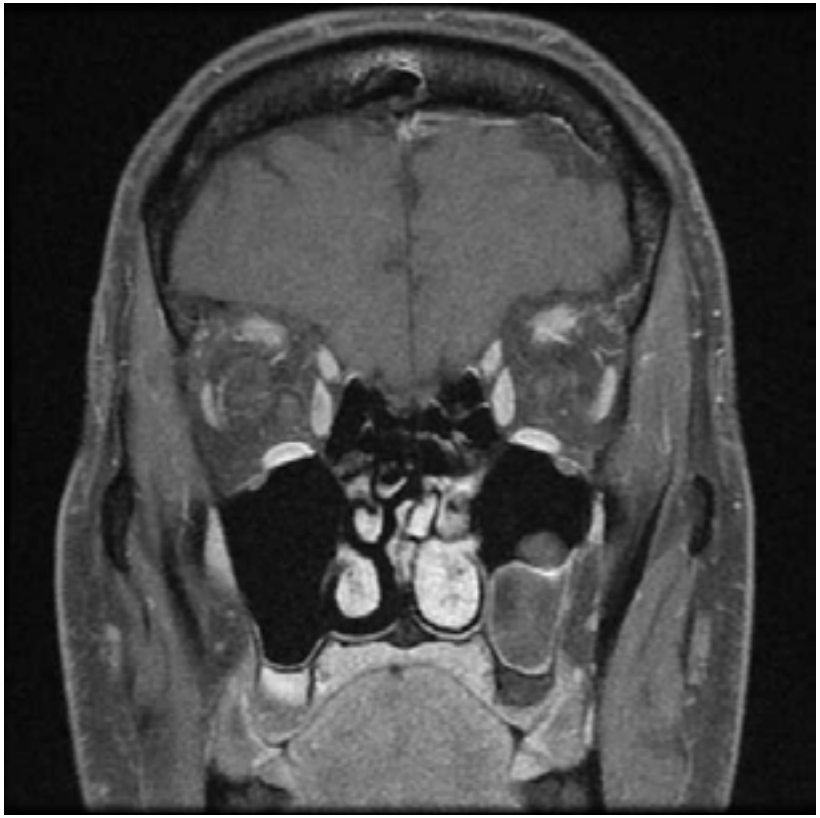


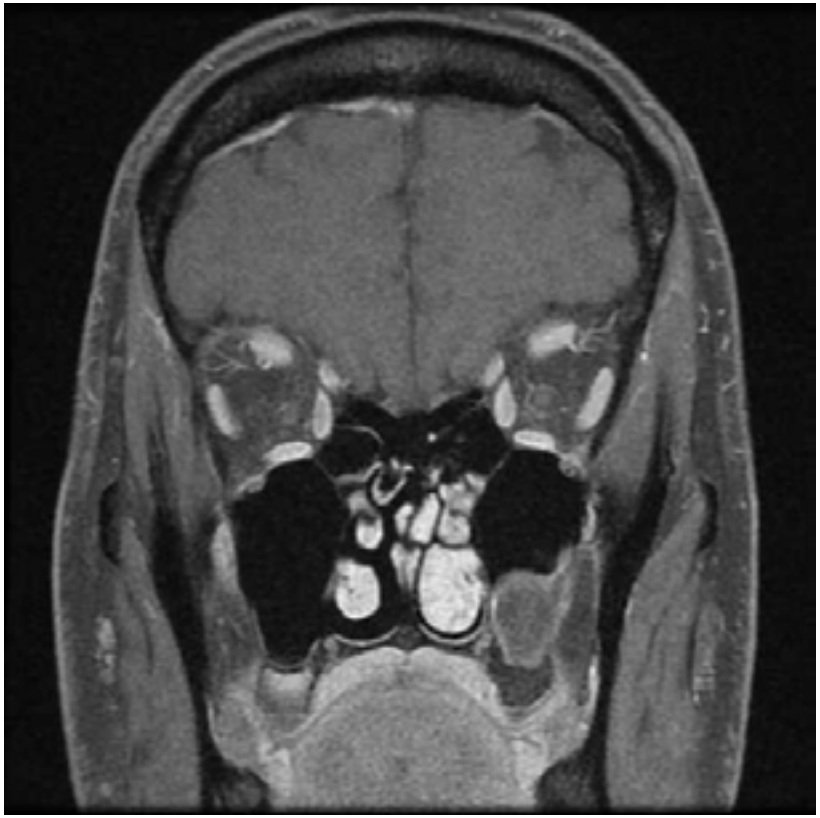


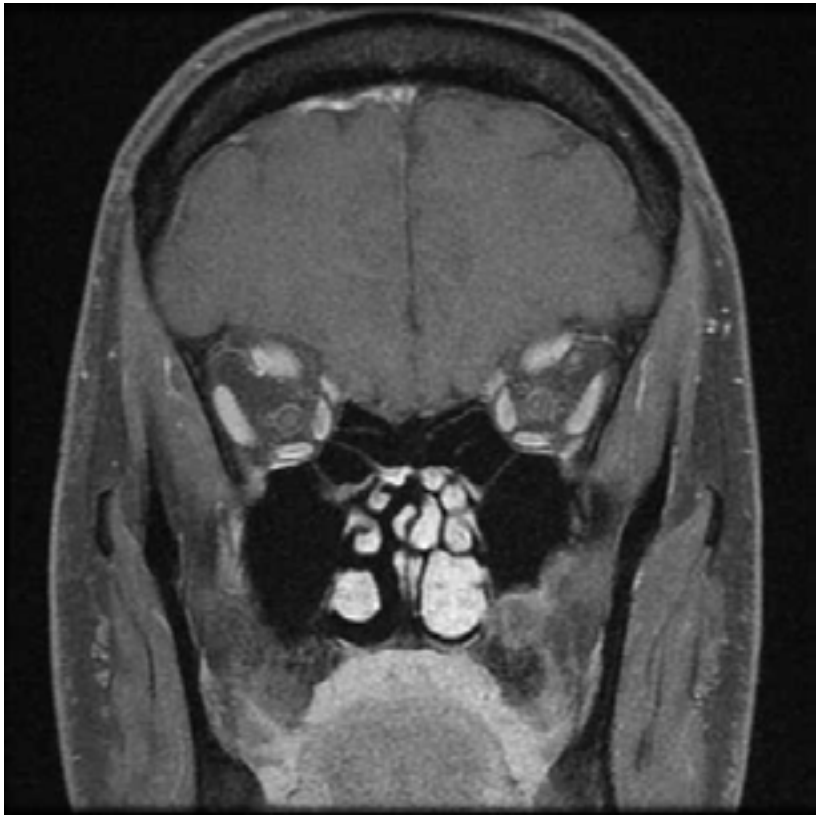


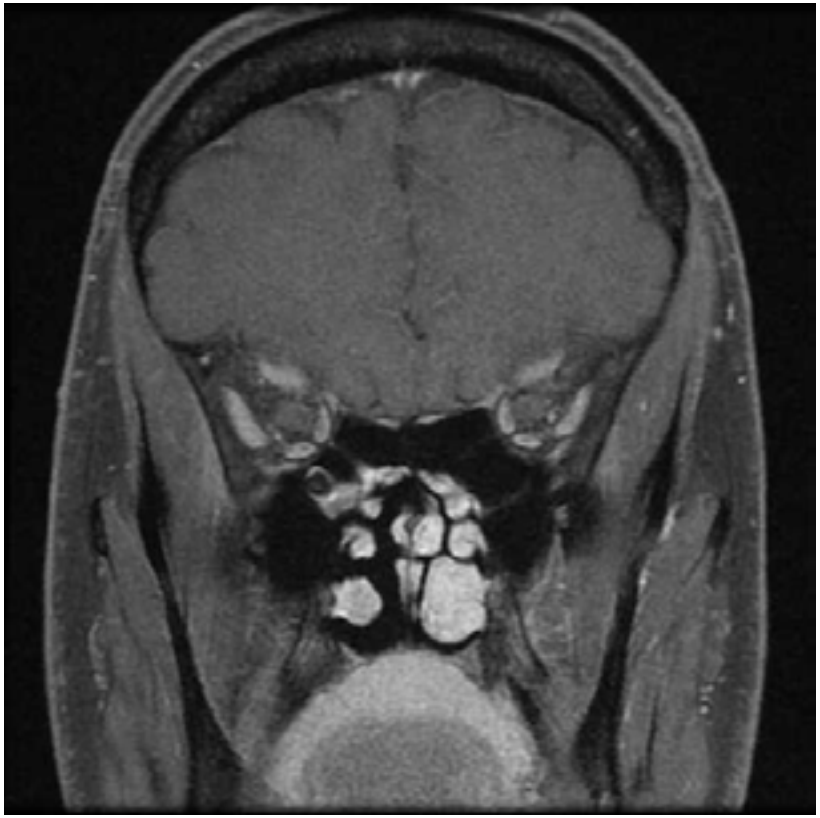


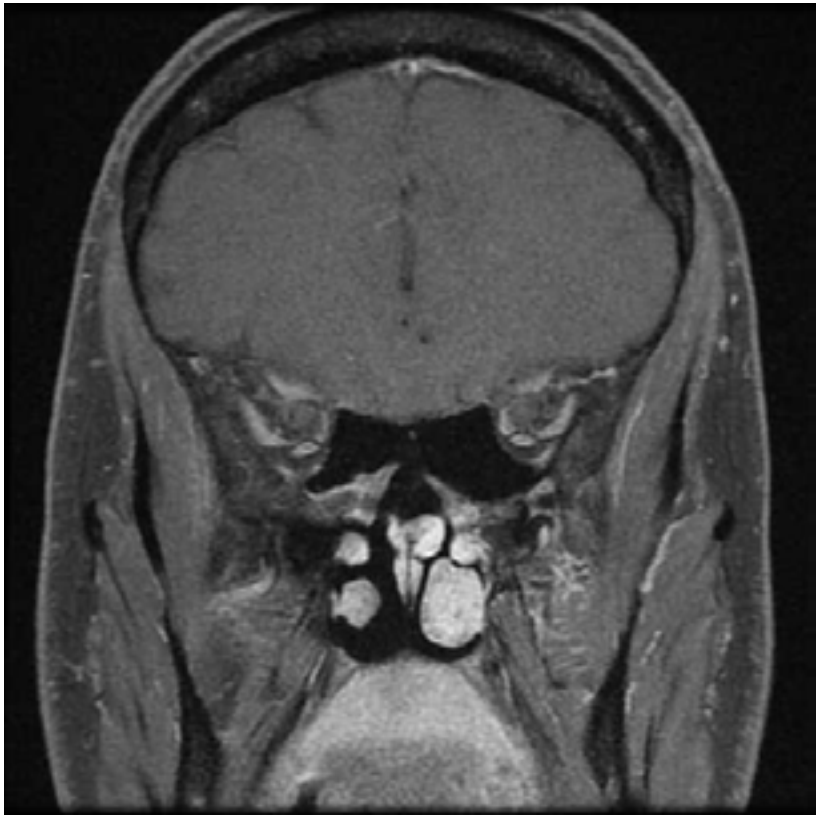


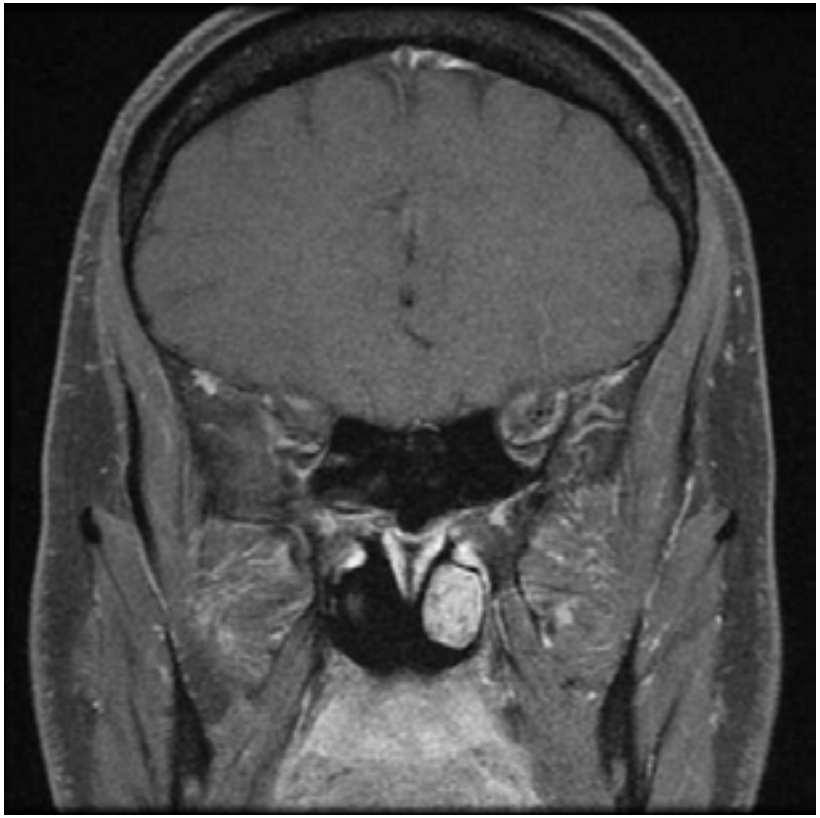


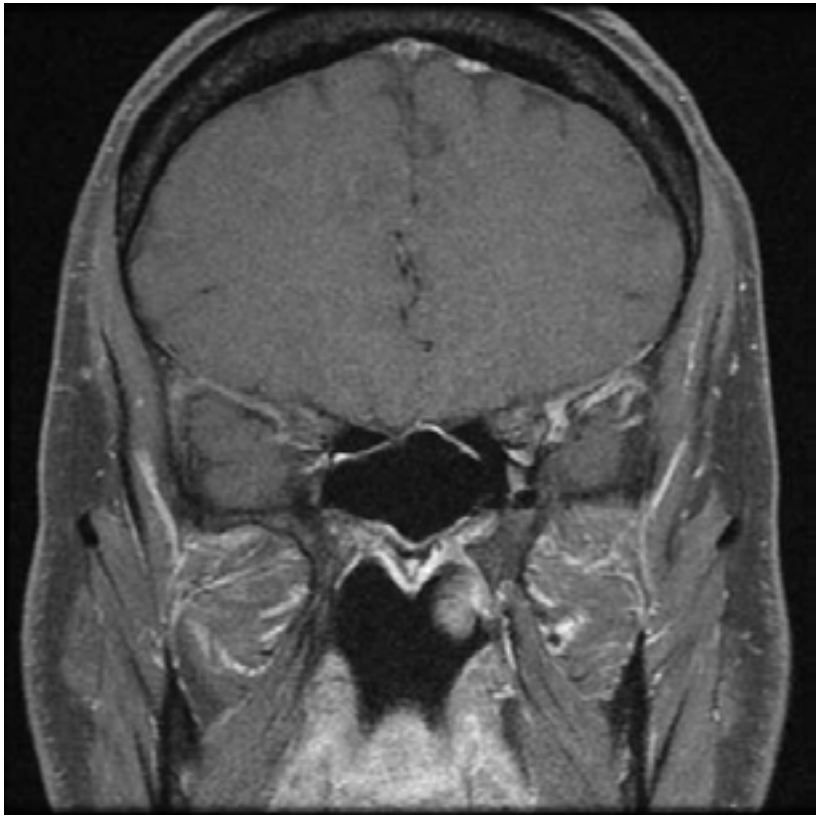


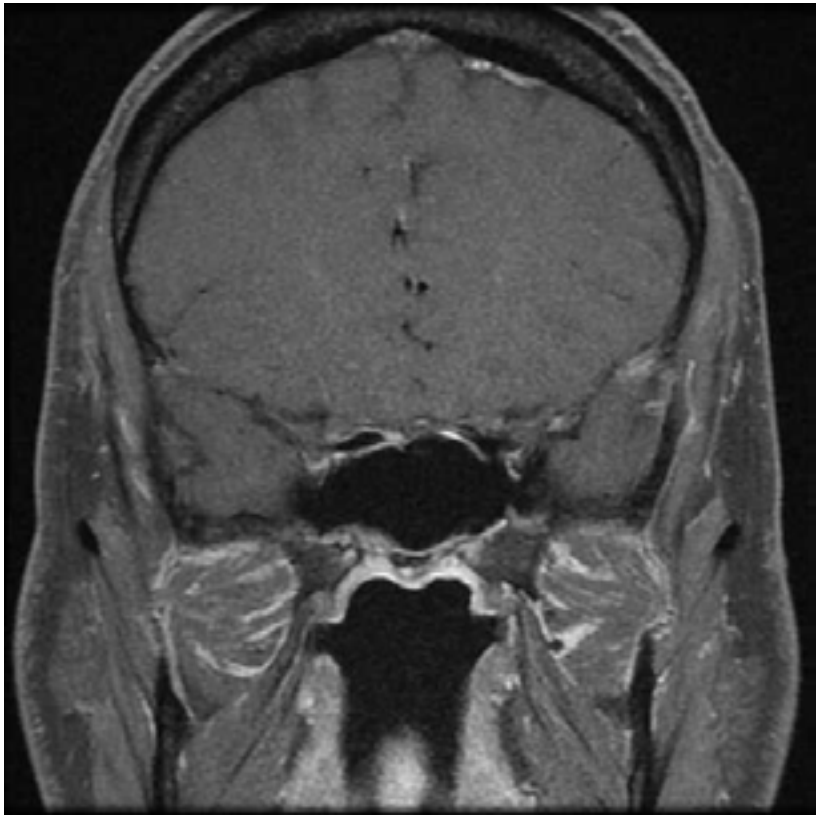


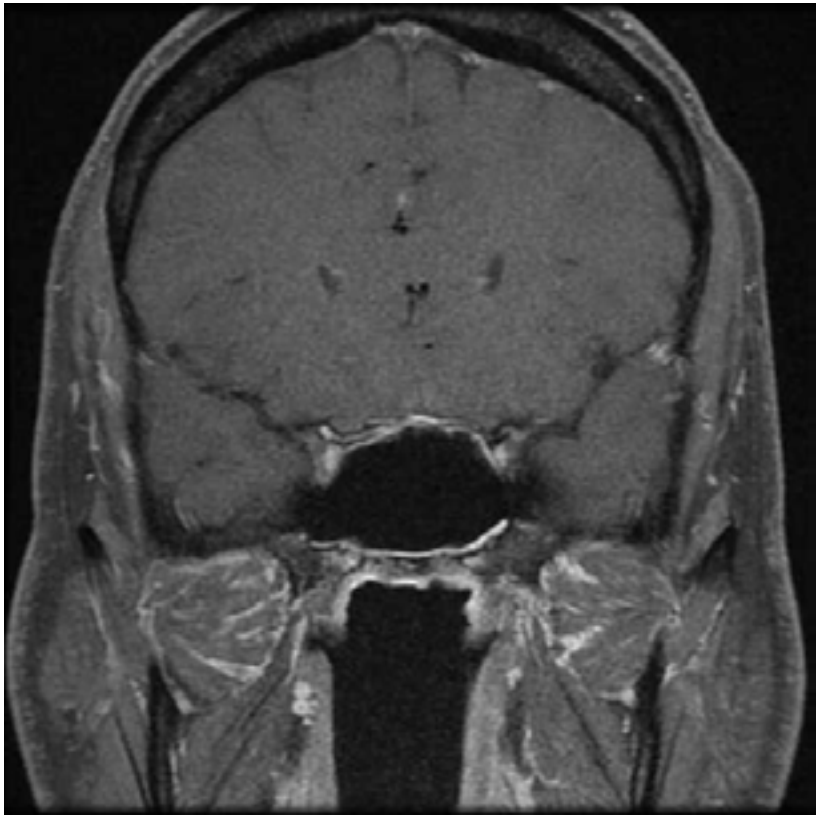


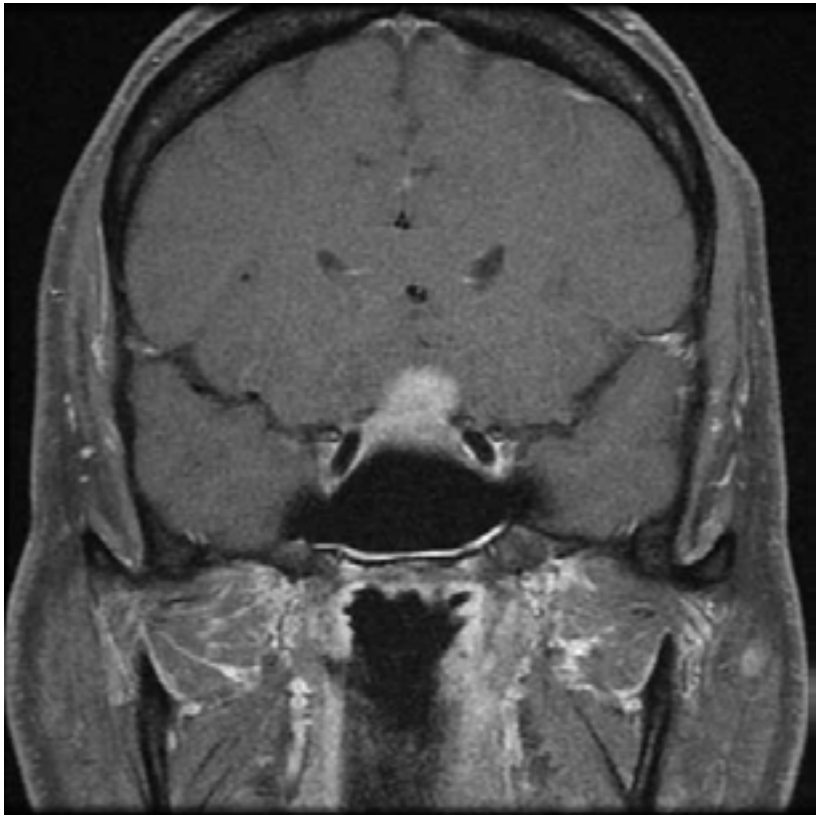


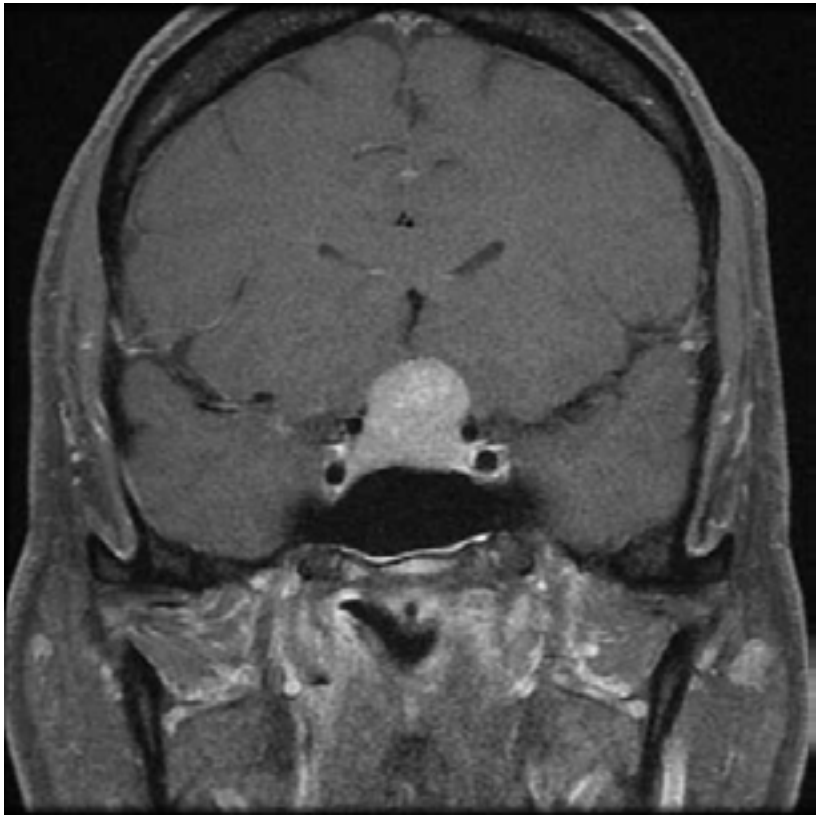


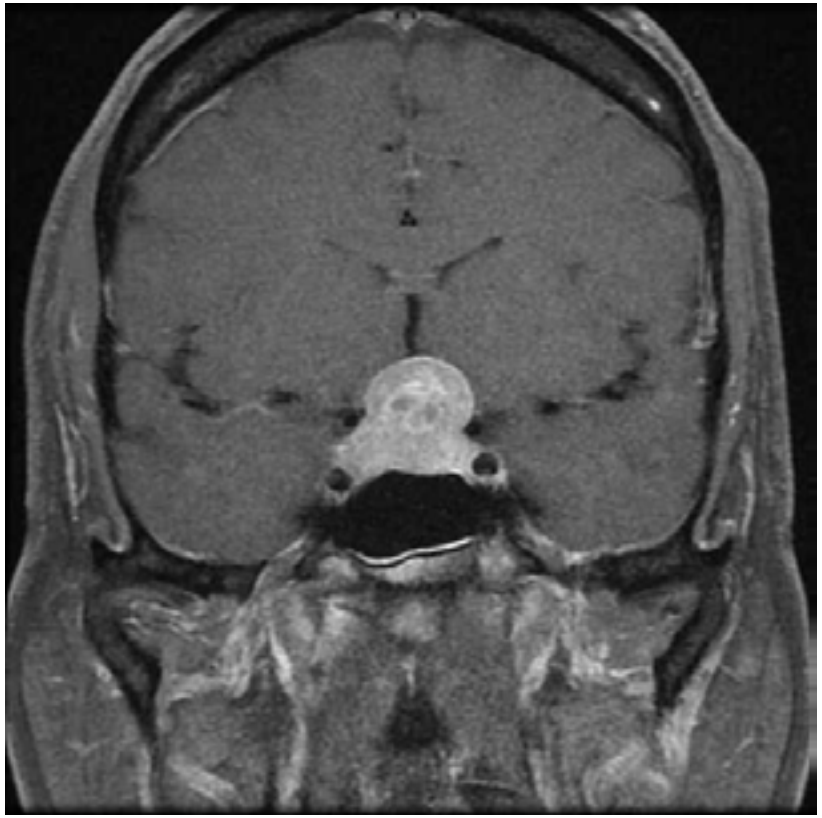


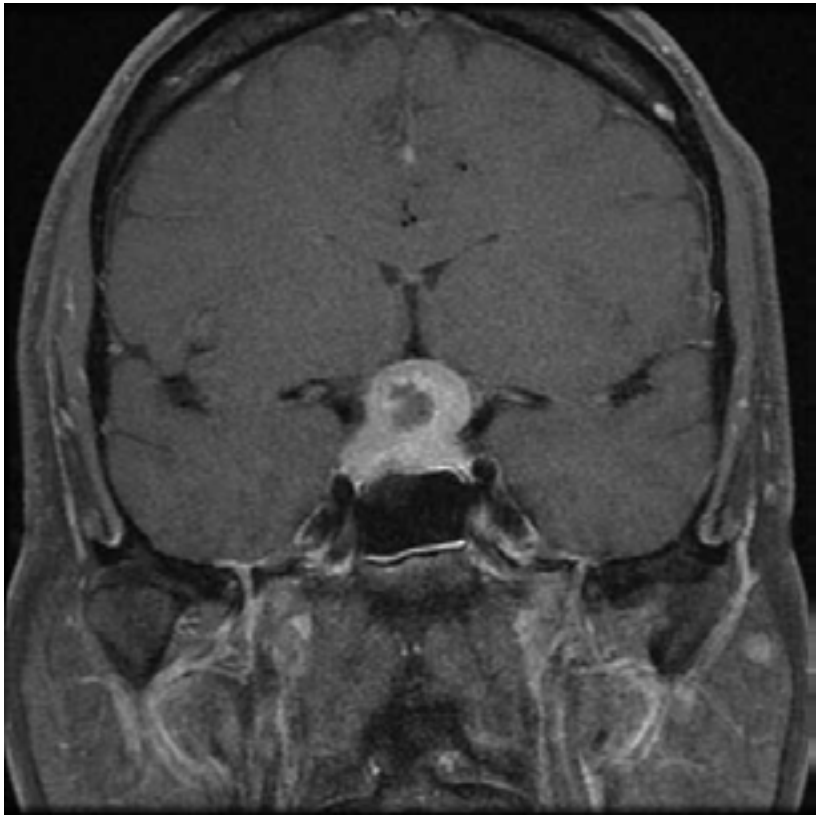


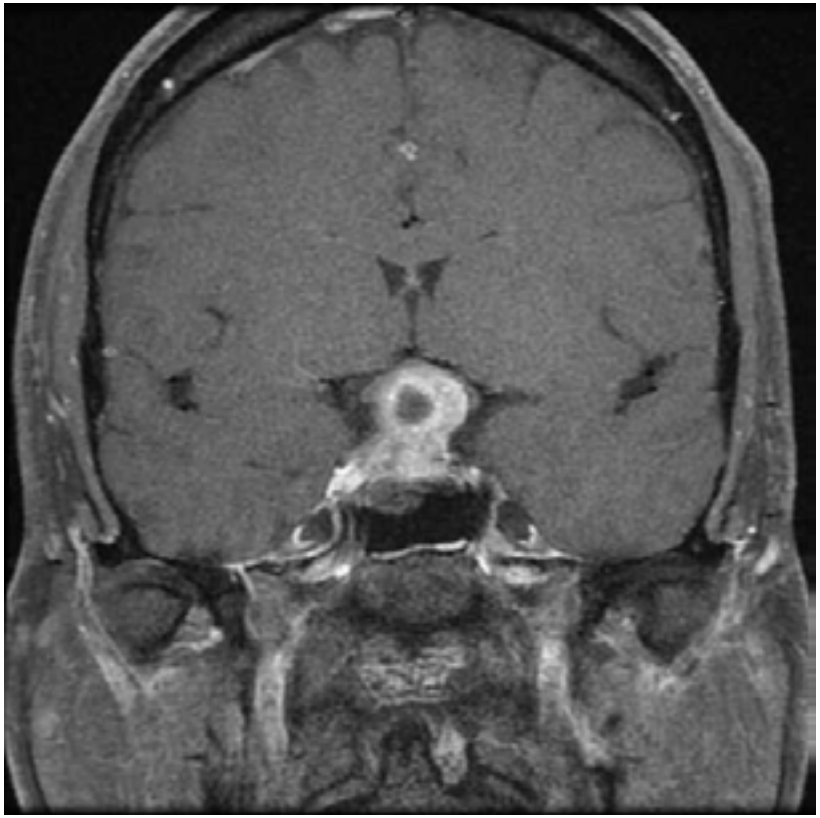


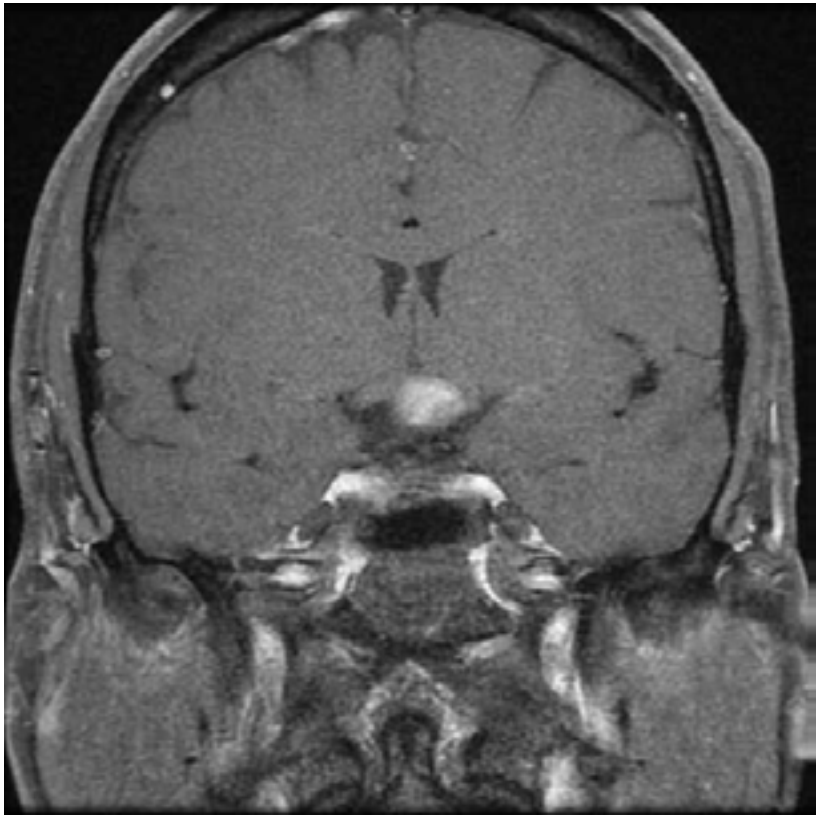


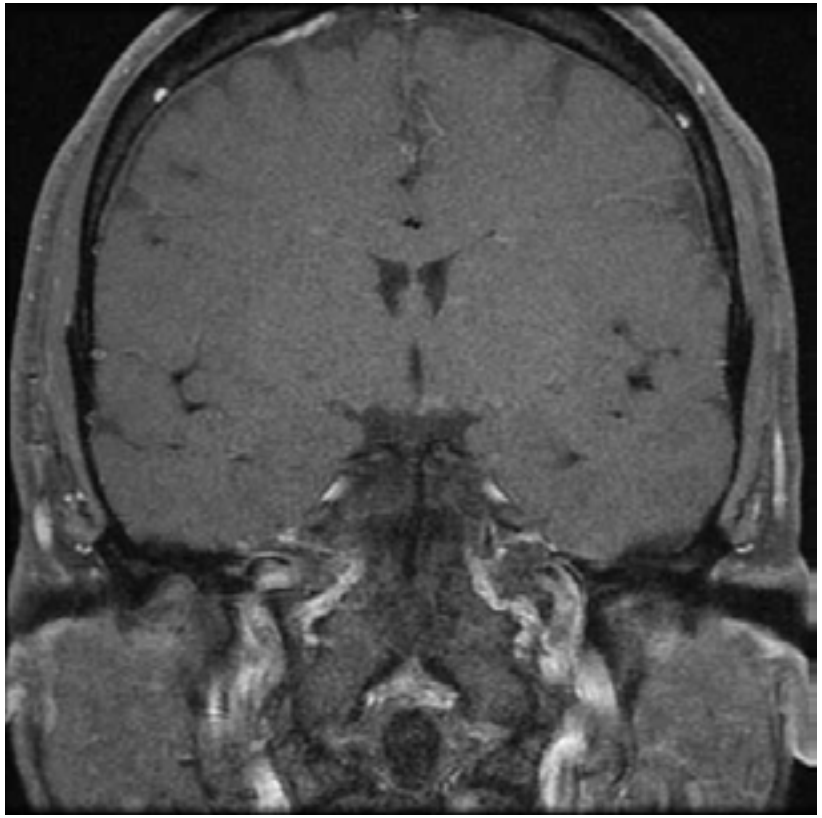


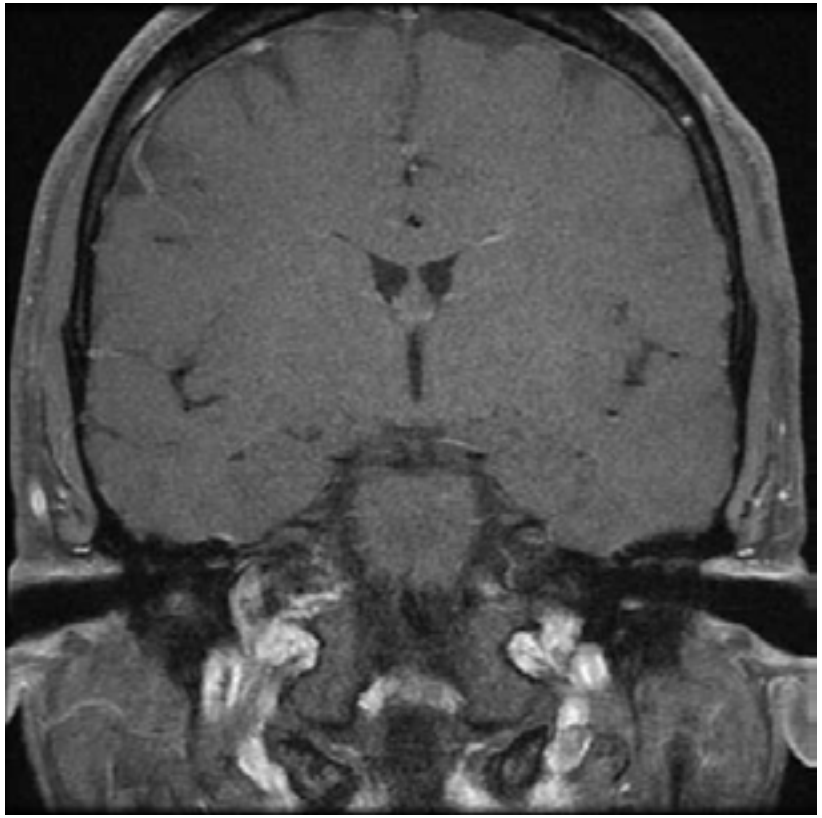


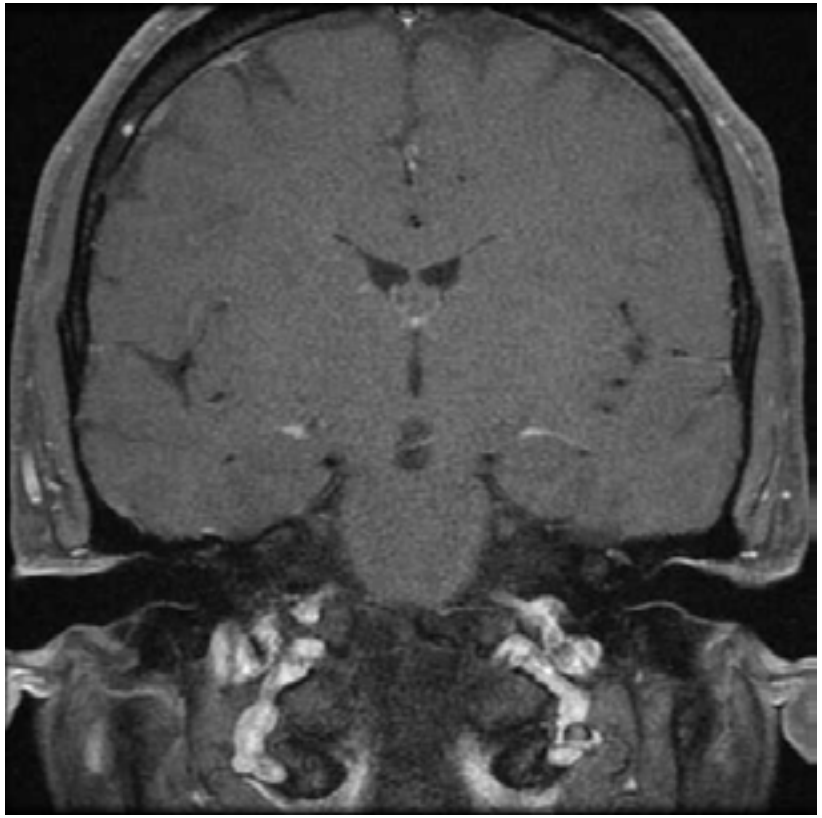


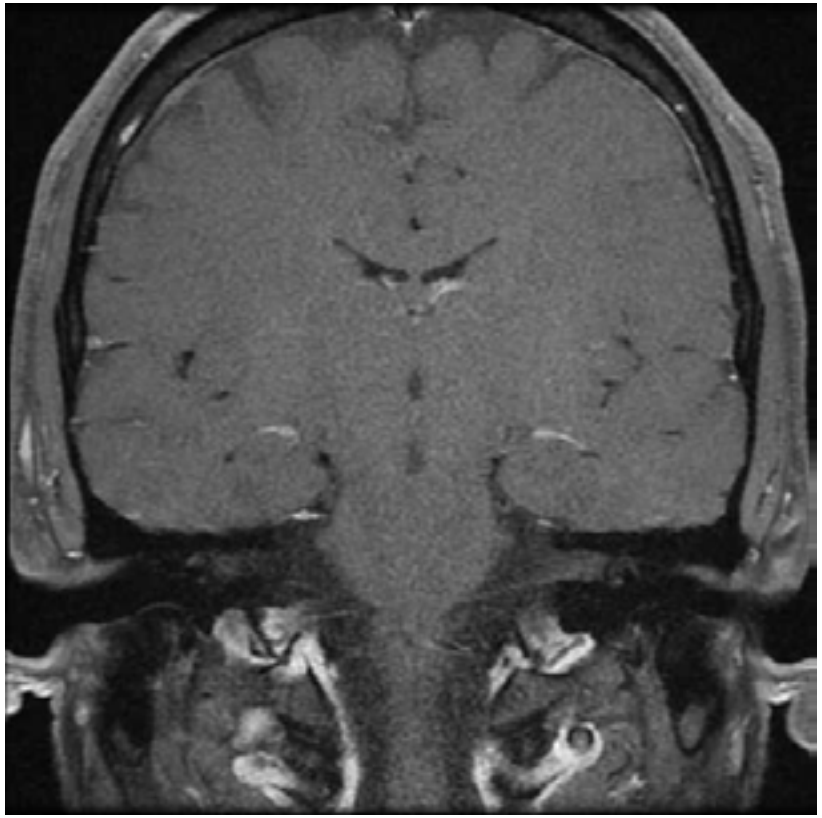


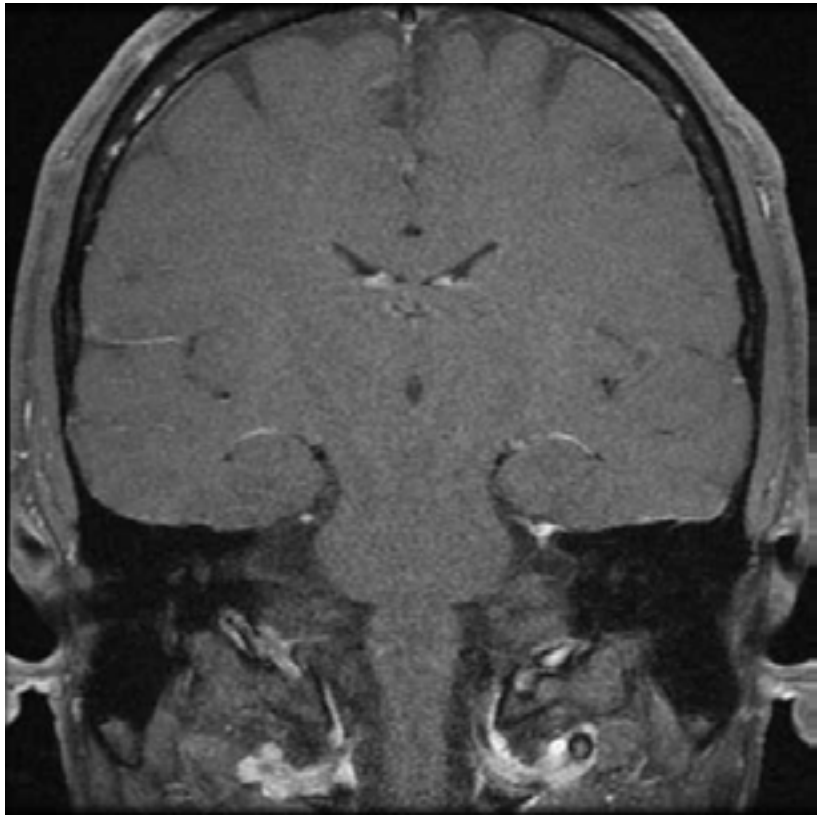


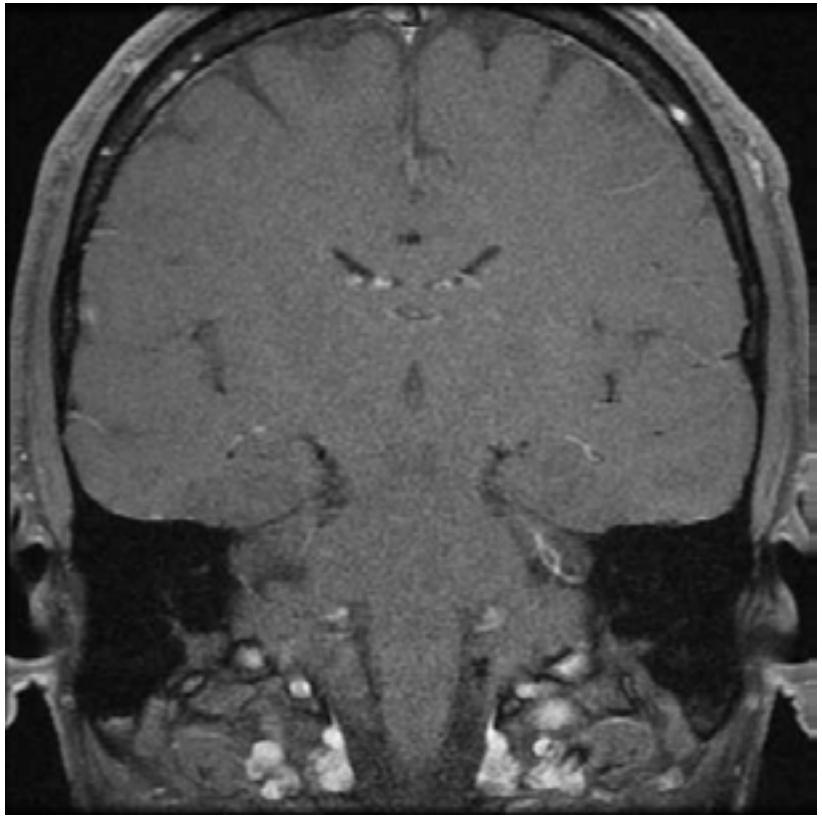


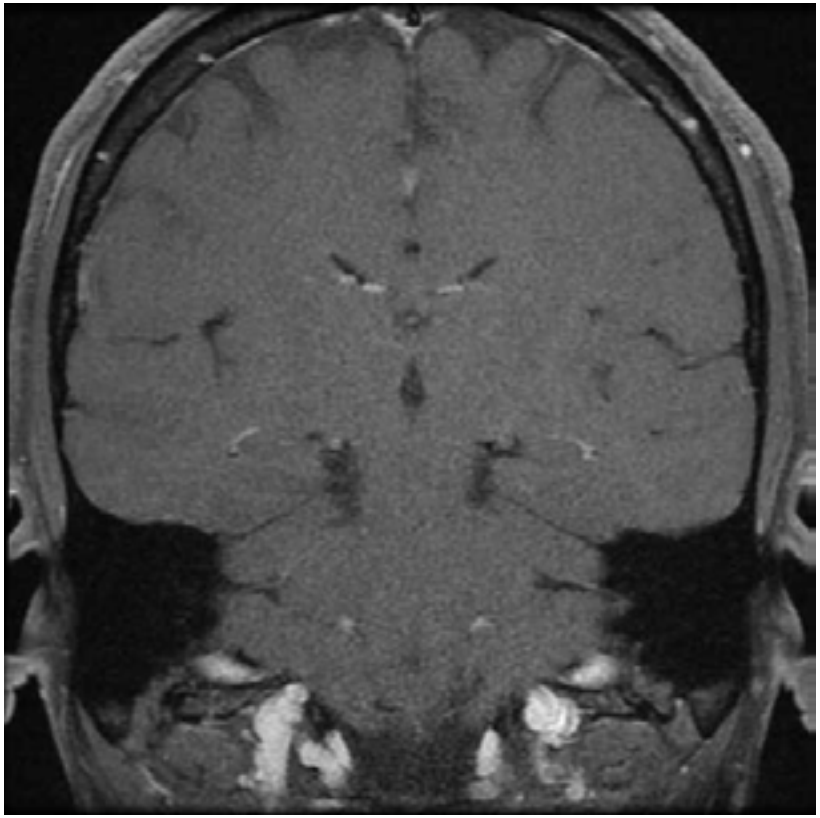


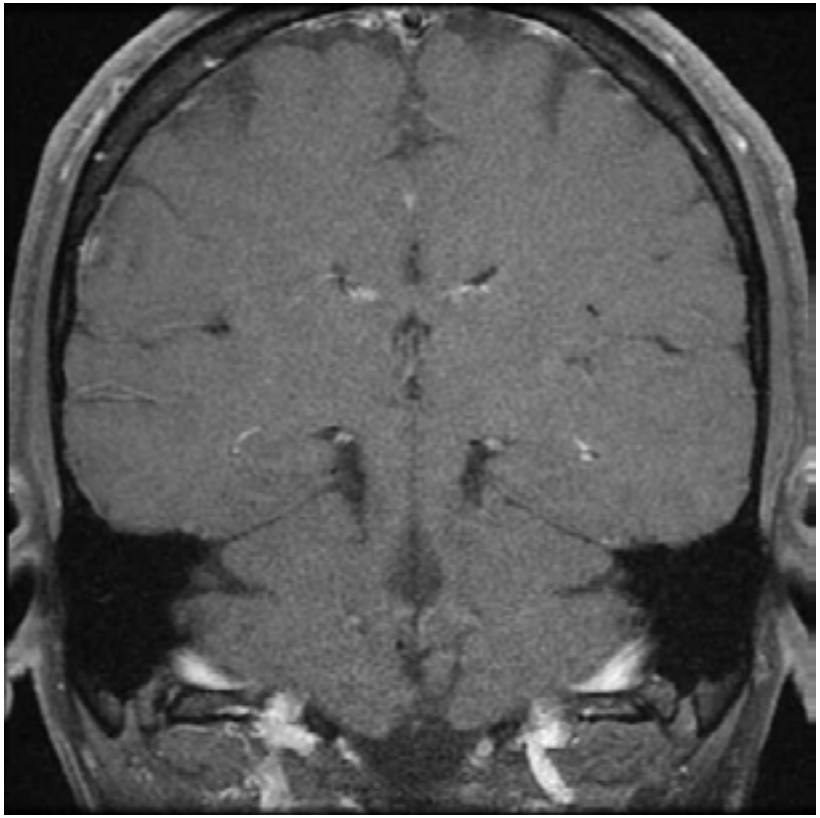


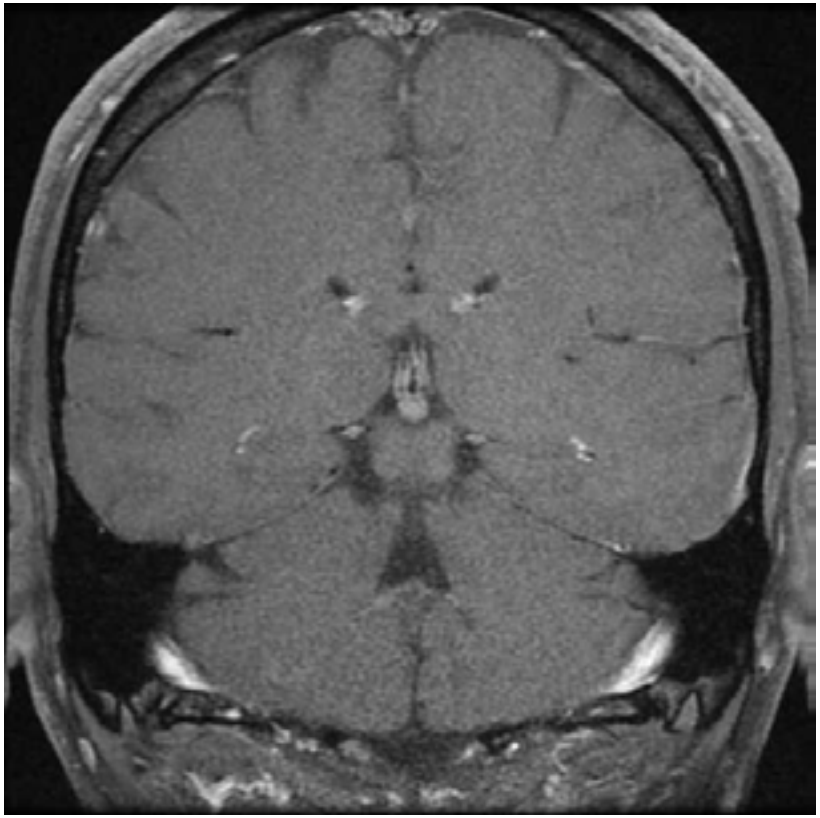




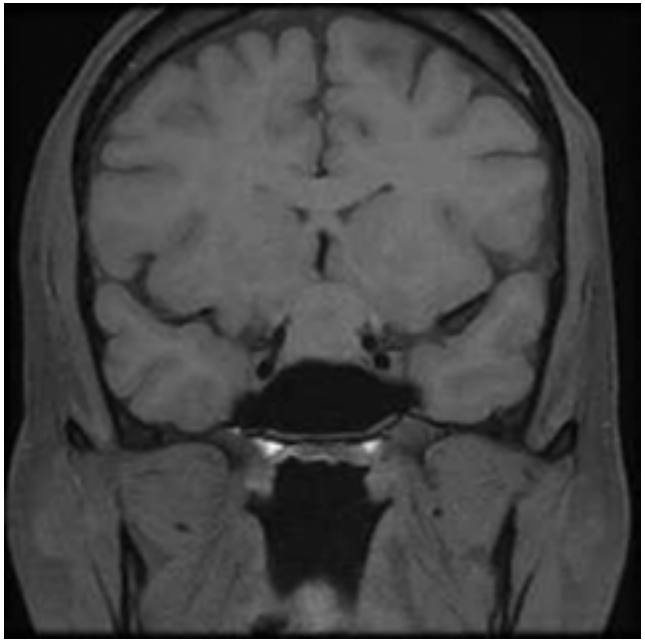


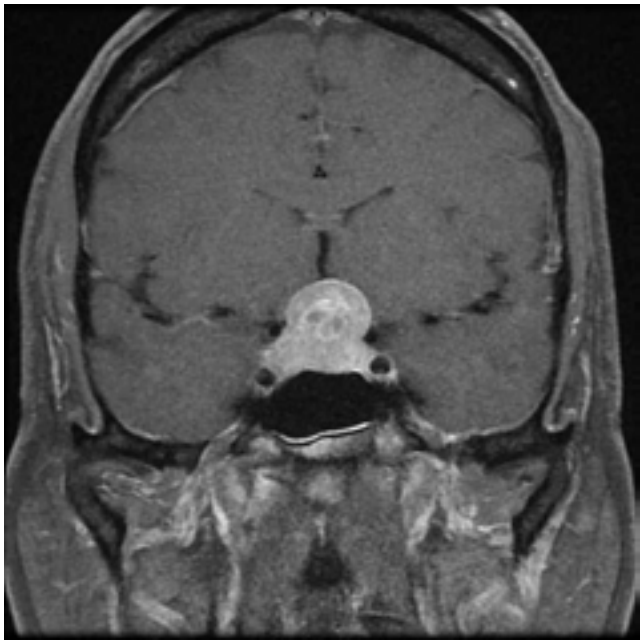


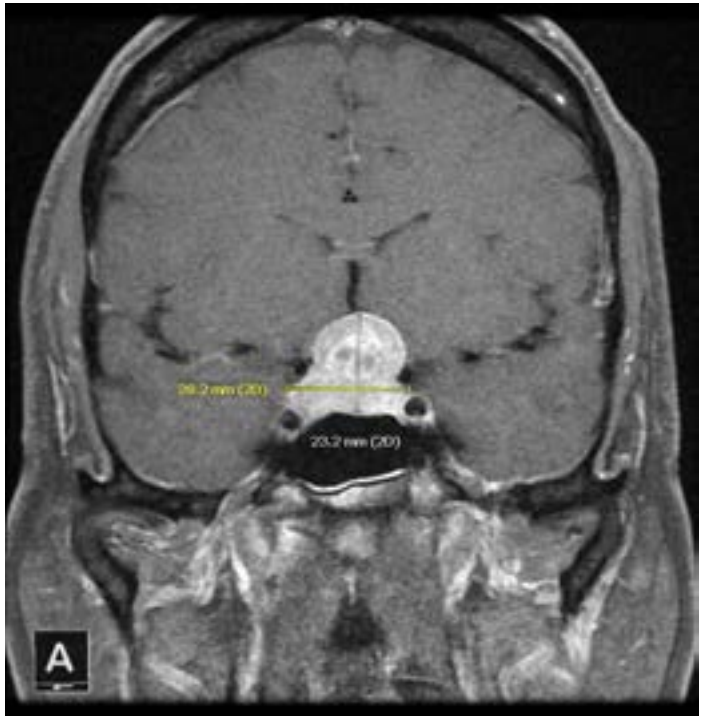




Contrast vs. No Contrast



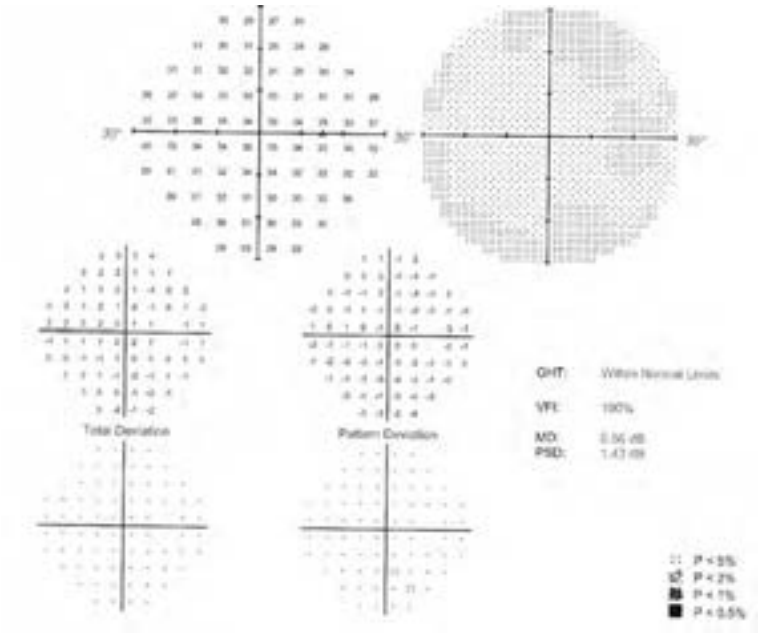



23.2 mm (2D)
A

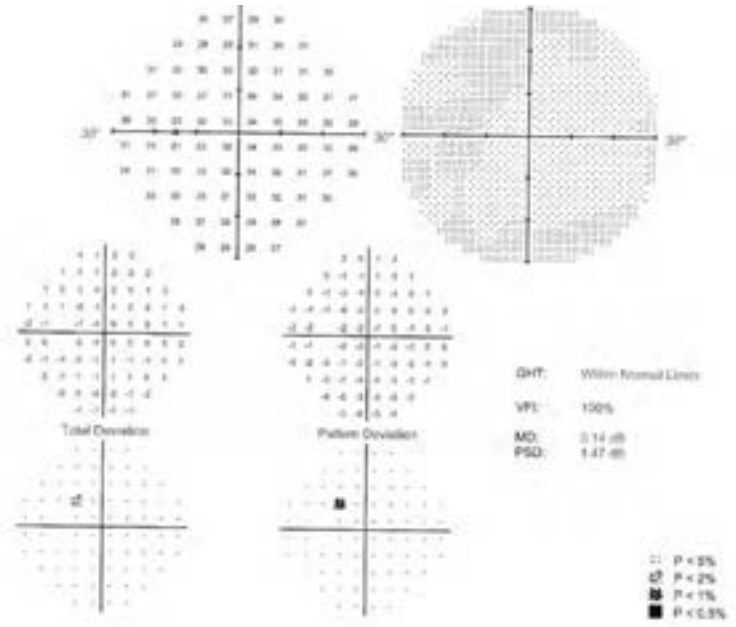
MRI Report

Large 2.8 cm enhancing sellar/suprasellar mass consistent with a macroadenoma with a significant mass effect on the optic chiasm. There is possible invasion of the right cavernous sinus. Recommend neurosurgical consultation.

OD Post-Surgical

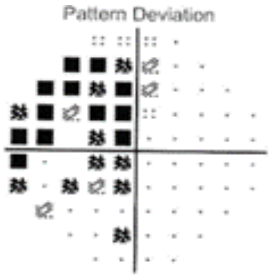


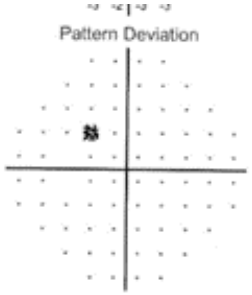
OS Post-Surgical



Pre- vs. Post-surgical VFs

OS





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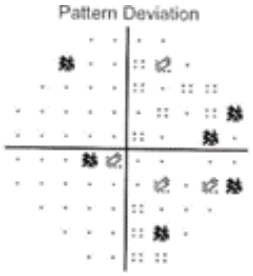
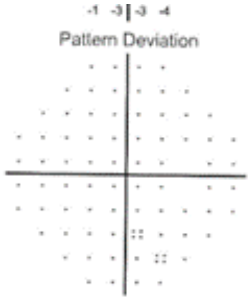




PANEL DISCUSSION

Pituitary Adenomas

These tumors are the most common cause of chiasmal dysfunction in adults, and they are very common, representing about 10–15% of all intracranial tumors

About 70% of pituitary adenomas occur in individuals aged 30 to 50 years, and only 3–7% occur in patients younger than 20 years

In general, they are benign epithelial neoplasms which rarely metastasize

Pituitary Adenomas

Pituitary adenomas can be classified functionally by their endocrine abnormality into two major groups: those with nonfunctional enlargement and those exhibiting hormone hypersecretion

Approximately one-quarter to one-third clinically apparent pituitary adenomas are nonfunctioning or nonsecreting

Pituitary Adenomas

- Since the chiasm is located directly above the pituitary in most instances, the crossing inferonasal fibers are usually the first to be disturbed by upward-growing adenomas, causing superotemporal defects respecting the vertical meridian

- Acuity is affected less commonly (estimated between 16–25%) than visual fields

- Disc pallor occurs in about 30% of patients

Pituitary Adenomas

- In 80–95% of microadenomas, a hypointense lesion is evident within the normal pituitary on T1-weighted MRI

- MRI should be sufficient to outline vascular structures and rule out coexisting aneurysms, so routine angiography is unnecessary in most preoperative assessments

Pituitary Adenomas

Optical coherence tomography (OCT) has demonstrated a strong relationship between vision loss and a decline in RNFL thickness in subjects with pituitary adenomas

RNFL thinning before treatment of these tumors is associated with a poorer prognosis for visual recovery

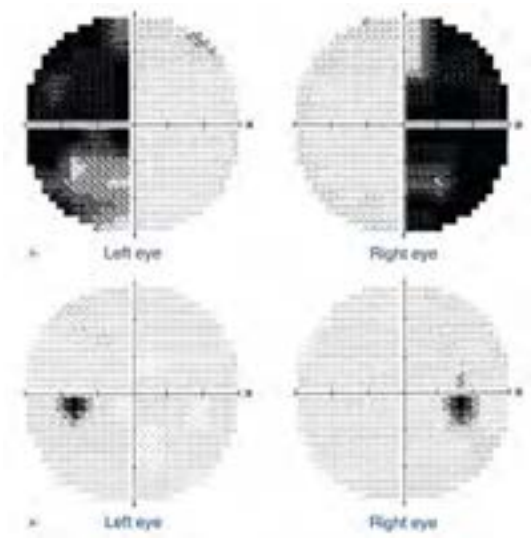
Pituitary Adenomas

Except for prolactinomas, the first-line treatment of symptomatic adenomas is transsphenoidal neurosurgery

Access to the sphenoid is usually via a sublabial or transnasal approach or combinations of both

At some institutions, the sella is exposed transnasally or transseptally using an endoscope, and the tumor removal is accomplished also endoscopically or with an operating microscope

Pituitary Adenomas



The prognosis for visual improvement is excellent following surgical or medical decompression

Optical coherence tomography predicts visual outcome for pituitary tumors

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ABSTRACT

We evaluate if the relationship between optical coherence tomography (OCT) of the retinal nerve fibre layer (RNFL) and visual outcome continued over long-term visual recovery in 107 patients undergoing pituitary decompression. Recently, it has been recognized that OCT of the RNFL has prognostic value in predicting visual outcomes after surgery for chiasmal compression caused by pituitary tumours. Patients were followed up at three time points: pre-operative (visit 1), 6–10 weeks post-operative (visit 2) and 9–15 months follow-up (visit 3). We found that patients with thin pre-operative RNFL had more severe visual field defects (mean deviation [MD] −9.22 *versus* −3.96 decibels [dB]; $p = 0.001$), but pre-operative visual acuity (VA) was good in both normal and thin RNFL groups (Snellen VA 6/5 and 6/4; $p = 0.039$). For those with thin RNFL the greatest improvement was between visit 2 and 3 (MD −7.1 dB *versus* −3.4 dB, respectively; $p < 0.001$) compared with pre-operative −9.8 dB. Normal RNFL patients showed greatest improvement between visits 1 and 2 (pre-operative −4.8 dB, visit 2 −2.0 dB, visit 3 −0.9 dB; $p = 0.001$). For long-term follow-up, 81.0% of eyes with normal RNFL, compared to 37.1% with thin RNFL ($p < 0.001$), achieved an MD of −2.00 dB (final visit). At final follow-up, 97.5% of normal RNFL eyes achieved VA of 6/12 or better compared with 88.2% with thin RNFL ($p = 0.034$). Our results indicate that long-term visual recovery after surgical decompression of pituitary lesions is predicted by pre-operative OCT RNFL. Patients with normal RNFL thickness show an increased propensity for visual recovery. This effect continues after long-term follow-up, however, most visual recovery occurs within the first 6–10 weeks.

OCT is very helpful in predicting visual outcome, and can help in determining urgency.

With surgical intervention, we expect significant improvement in visual function.

A delay in treatment could worsen visual prognosis.

Danesh-Meyer HV, Wong A, Papchenko T, et al. Optical coherence tomography predicts visual outcome for pituitary tumors. *Journal of Clinical Neuroscience*. 2015:22(7):1098-1104

10;68(2):346-351. doi: 10.4103/0028-3886.280634.

An Analysis of Retinal Nerve Fiber Layer Thickness before and after Pituitary Adenoma Surgery and its Correlation with Visual Acuity

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Affiliations + expand

PMID: 32189695 DOI: 10.4103/0028-3886.280634

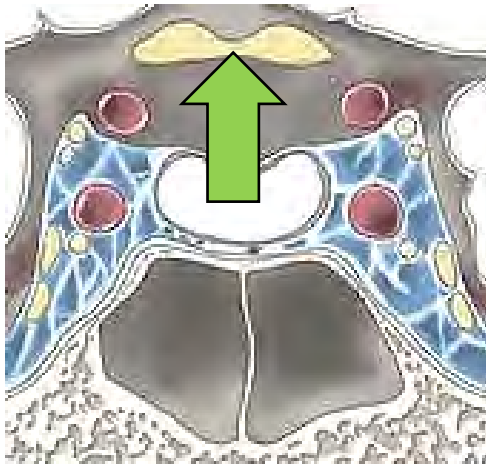
Introduction: Pituitary adenomas comprise approximately 10% of all intracranial tumors. Initially, subtle changes occur in the field of vision, which are difficult to assess clinically. It has been seen that following surgery of pituitary macroadenoma, total recovery of normal vision occurs in 35% of the patients, improvement of vision occurs in 60%, and in the rest there is no change in vision. Retinal nerve fiber layer thickness (RNFLT) undergoes retrograde degeneration following compression of optic apparatus by pituitary tumor. We planned a study to evaluate RNFLT before and after pituitary adenoma surgery and its correlation with visual acuity.

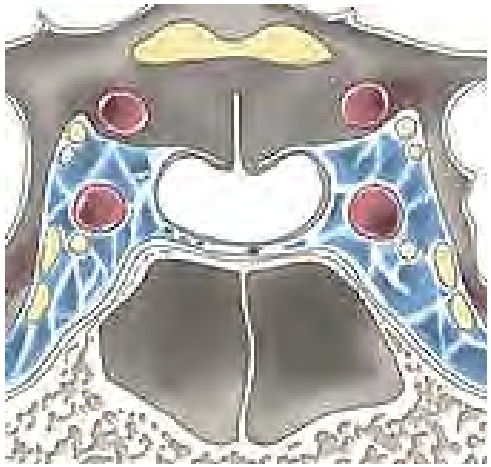
Material and methods: Twenty patients (40 eyes) with diagnosed pituitary adenoma were included in the study. Preoperative visual acuity, fundus and RNFL thickness were calculated using spectral-domain OCT Optovue, Heidelberg Engineering, Heidelberg, Germany (RT 100 version 5.1), and postoperative measurement was done after 1 and 3 months. Four-quadrant mean of RNFLT was calculated. Results were tabulated and analyzed.

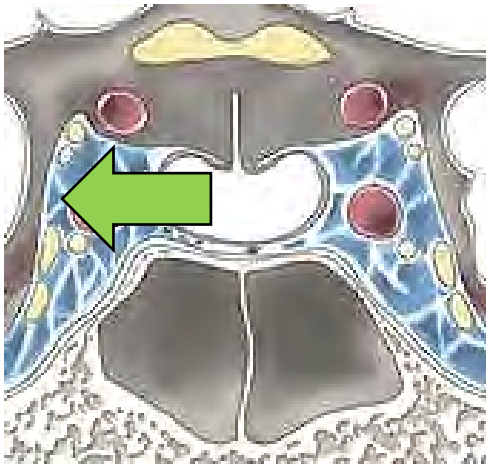
Statistical analysis: Results of the study were analyzed using IBM SPSS Statistics version 19.0.

Results: There was no significant change in RNFLT after pituitary adenoma surgery, and it was found that patients with RNFLT within normal range preoperatively showed improvement in visual acuity after pituitary surgery. On the other hand, patients who had thinned-out RNFLT preoperatively showed no improvement in visual acuity. It was also found that once optic disc pallor sets due to chronic compression, then chances of its reversion to normal depend on its grading: only mild pallor disc has some chance to revert to normal, whereas moderate and severe pallor do not revert to normal.

Conclusion: RNFLT and optic disc can be used as prognostic factors for evaluation of visual outcome in pituitary adenoma surgery.







- **AFFERENT VISUAL SYSTEM EFFECTS**

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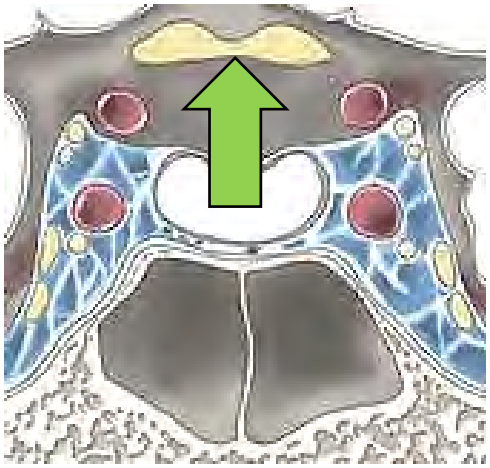
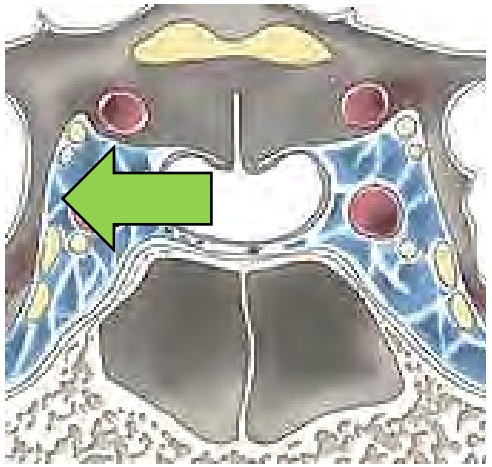


- **AFFERENT VISUAL SYSTEM EFFECTS**

Vision loss
Reduced visual acuity
Visual field loss
Dyschromatopsia
Relative afferent pupillary defect possible

Diplopia
Ocular misalignment
Cranial nerve III, IV, VI palsies



- **EFFERENT VISUAL SYSTEM EFFECTS**

It is important to assess for efferent manifestations of pituitary adenomas!

Pituitary Tumors are RARE in CHILDREN

- Only 3% of all pediatric intracranial tumors
- When they do occur in kids, **they are more likely to be secreting (functional) tumors**
- Pituitary functions are important!

CRANIOPHARYNGIOMA in KIDS

- most common suprasellar brain tumor in children
- most common tumor associated with severe permanent visual impairment in children
  - 30% present with vision loss
  - 30% experience visual decline after initial diagnosis & tx
    - Need to watch closely even after treatment
  - Visual acuity loss and optic atrophy are common
  - 58% visual impairment in at least one eye
  - 10% being legally blind in both eyes

Not Every Pituitary Adenoma Needs Surgery

But, we should co-manage all of them with neurosurgery.

If there is no vision loss, patient is asymptomatic, there is no significant chiasmal compression and labs are normal, sometimes the management plan involves only surveillance.

- Interval MRIs
- Interval VFs
- Interval OCTs

Pituitary Function Tests

- Prolactin
- AM Cortisol
- ACTH (adrenocorticotropic hormone)
- IGF-1 (insulin-like growth factor 1)
- GH (growth hormone)
- TSH (thyroid stimulating hormone), fT4
- LH, FSH (luteinizing hormone, follicle stimulating hormone)
- Testosterone / Estrogen

Types of Secretory or Functional Pituitary Adenomas

- **Prolactin-secreting pituitary adenoma (Prolactinoma)**
  - Women: loss of menstrual periods and breast milk production
  - Men: lower testosterone levels, leading to diminished sexual interest
- **Growth hormone-secreting pituitary adenoma**
  - An excessive production of growth hormone (GH) causes enlarged hands and feet and other changes in the body
    - Acromegaly in adults
    - Gigantism in children
- **ACTH-secreting pituitary adenoma**
  - Excessive ACTH hormone production causes Cushing's disease.
  - Symptoms include unexpected weight gain, easy bruising of skin muscle, weakness
- **TSH-secreting pituitary adenoma (Thyrotropinoma)**
  - Excessive TSH hormone production leads to hyperthyroidism.
  - very rare

PROLACTINOMA

SYMPTOMS:

AMENORRHEA (absence of menstruation)

GALACTORRHEA (discharge from breasts)

INFERTILITY (anovulation)

GYNECOMASTIA (swelling of male breast tissue)

DECREASED LIBIDO (sexual desire)

IMPOTENCE

TREATMENT OF PROLACTINOMAS

- ***MEDICAL TREATMENT***
  - **DOPAMINERGIC AGONISTS**
  - Reduce Prolactin Synthesis
  - Decrease Size of Prolactinoma
    - **BROMOCRIPTINE** (ERGOSET, PARLODEL)
    - **CABERGOLINE** (DOSTINEX)
    - **PERGOLIDE** (PERMAX)

Need to get pituitary function tests before deciding on treatment of pituitary adenomas.

You should get the labs prior to patient seeing neurosurgery, so they have all the necessary data to make a treatment decision.

Both imaging and pituitary function lab testing should be obtained prior to the neurosurgical consult (except in emergent cases).

* Random cortisol and ACTH if possible

Pituitary Apoplexy

PITUITARY APOPLEXY
Sudden infarct in, or bleed of pituitary adenoma

Hemorrhagic and ischemic

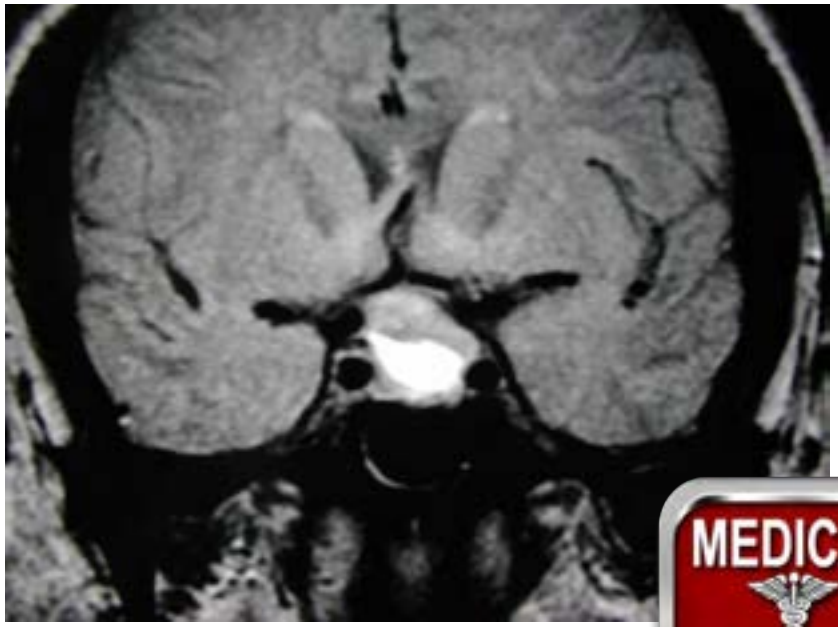
Occurs in 0.6-10% of new pituitary adenomas
Up to 2% of previously treated adenomas

PANHYPOPITUITARISM...
LOSS OF GH, ACTH, LH, FSH, Prolactin, TSH
(all produced in anterior pituitary)

ADRENAL FAILURE CAN LEAD TO SHOCK AND DEATH

VISION LOSS FROM MASS EFFECT

SUB-ARACHNOID HEMORRHAGE



PITUITARY APOPLEXY Clinical Syndrome

- **SUDDEN HEADACHE, NAUSEA, EMESIS**
- **VISUAL LOSS**
- **OPHTHALMOPLEGIA (Cavernous sinus involvement)**
- **FEVER**
- **STIFF NECK (sub-arachnoid hemorrhage)**
- **HORMONE INSUFFICIENCY**

Not every case is textbook. Can be partial and more insidious.

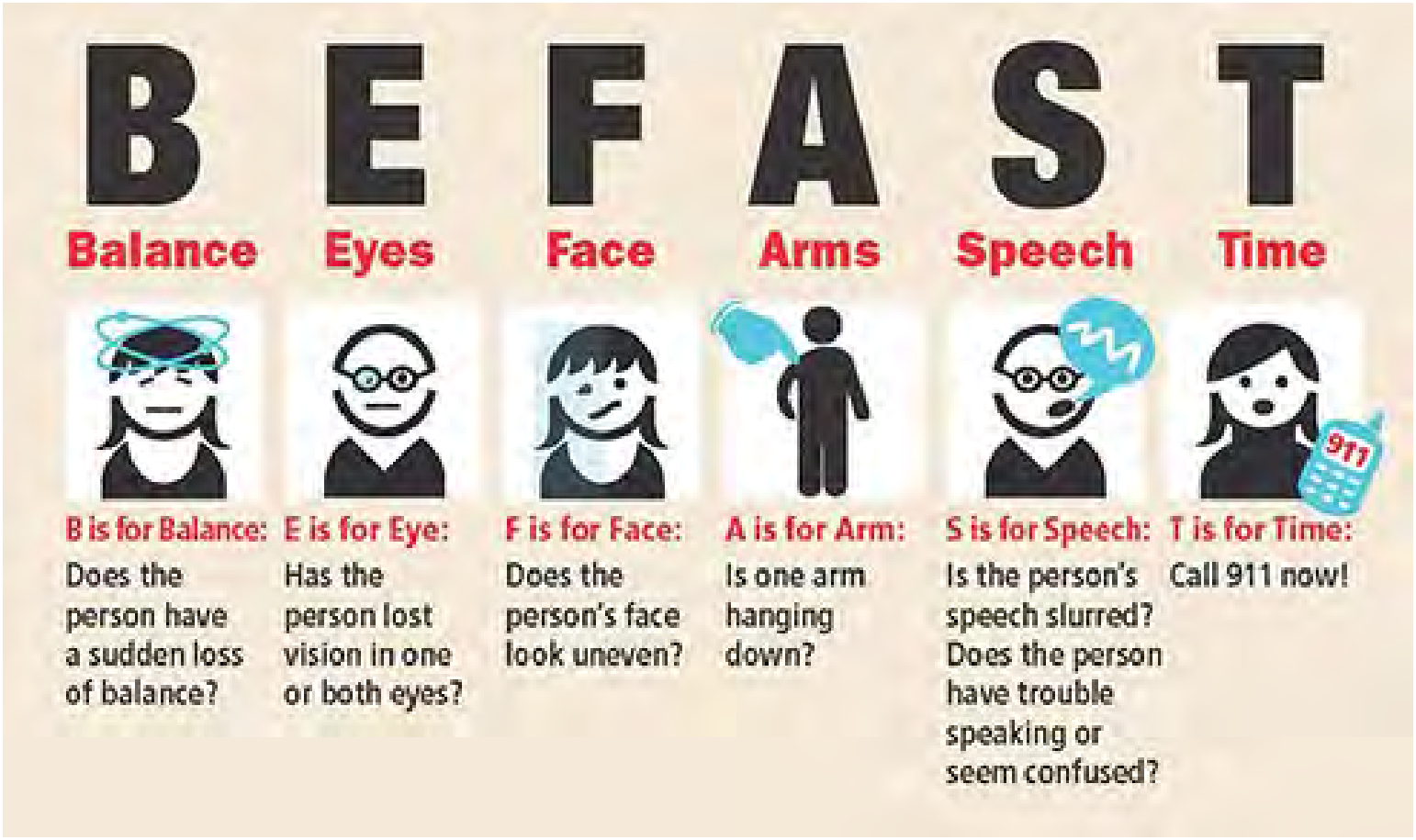
We need to carefully assess for visual field defects and ocular motility abnormalities in all patients, whether or not they are symptomatic!

Stroke Background Information

Stroke

- 80% of strokes are preventable!!
- 1/5 die within a year of 1st stroke
  - Deaths from stroke are dropping due to development of regional stroke centers
- Know where the stroke center(s) is/are in your area!
- Ask your patients about stroke symptoms
  - Both ocular and non-ocular
- Measure BP and pulse regularly

Beyond F.A.S.T. – Other Symptoms You Should Know



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Role of Optometrists

- Preventative Measures
  - Identify stroke risk factors
  - Educate patients
  - Refer as necessary
- Identify Acute Stroke / TIA
  - Get patient immediate (emergent) work-up/treatment as necessary
- Determine if Deficits are from old strokes or if they indicate a new stroke/other process (localization)
- Assess visual function after stroke
  - Improve visual function where possible
  - Comment on driving ability

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Location of stroke (infarct)

- Anterior Circulation
  - Carotid artery
  - Anterior cerebral artery
  - Middle cerebral artery
- Posterior Circulation
  - Vertebro-basilar
  - Posterior cerebral artery

The location of the involved circulation/infarct determines the clinical presentation (Remember: Not everyone's anatomy is the same! – can have variants)

Knowing the anatomy and its corresponding function is key to stroke localization

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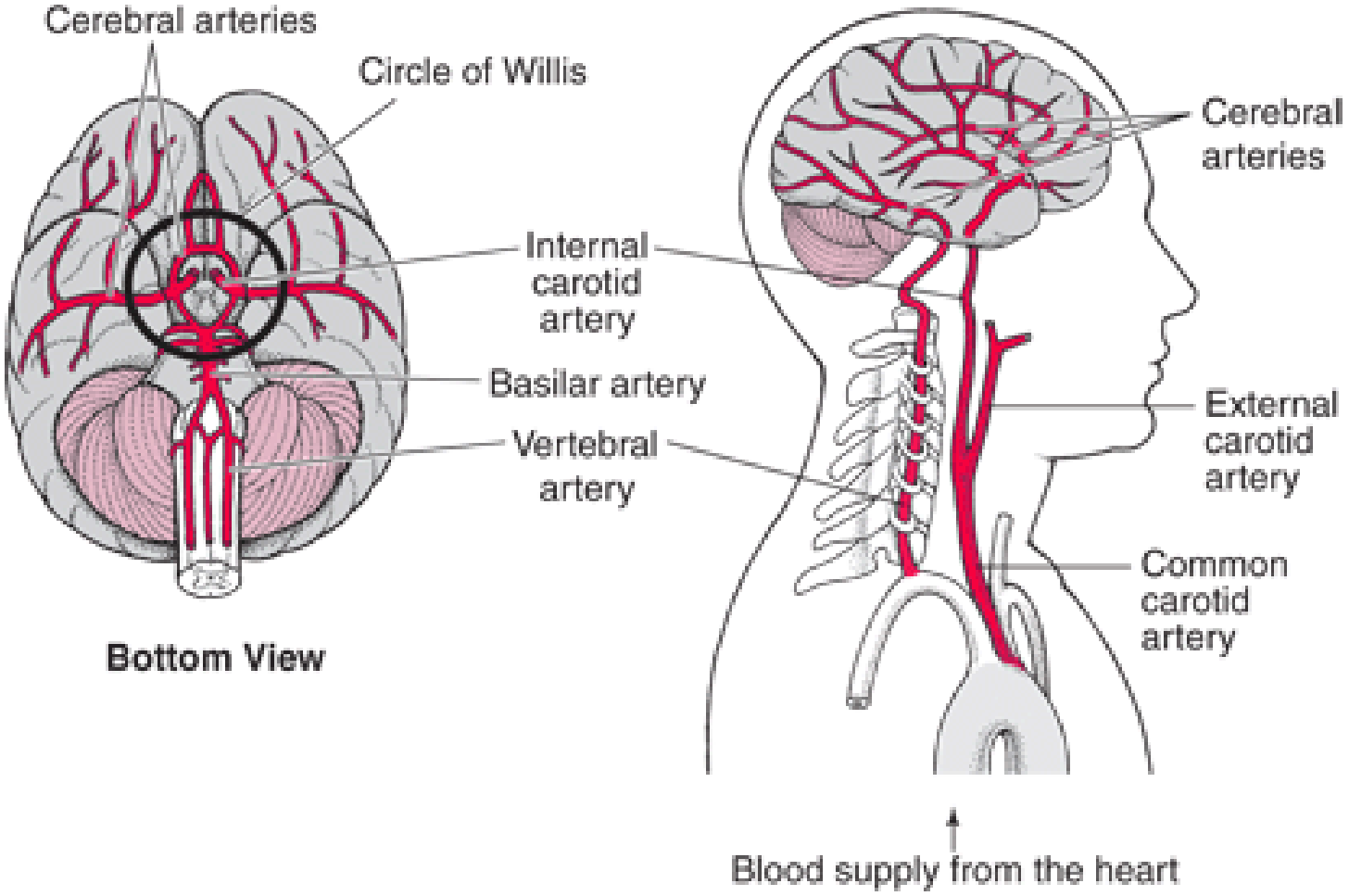
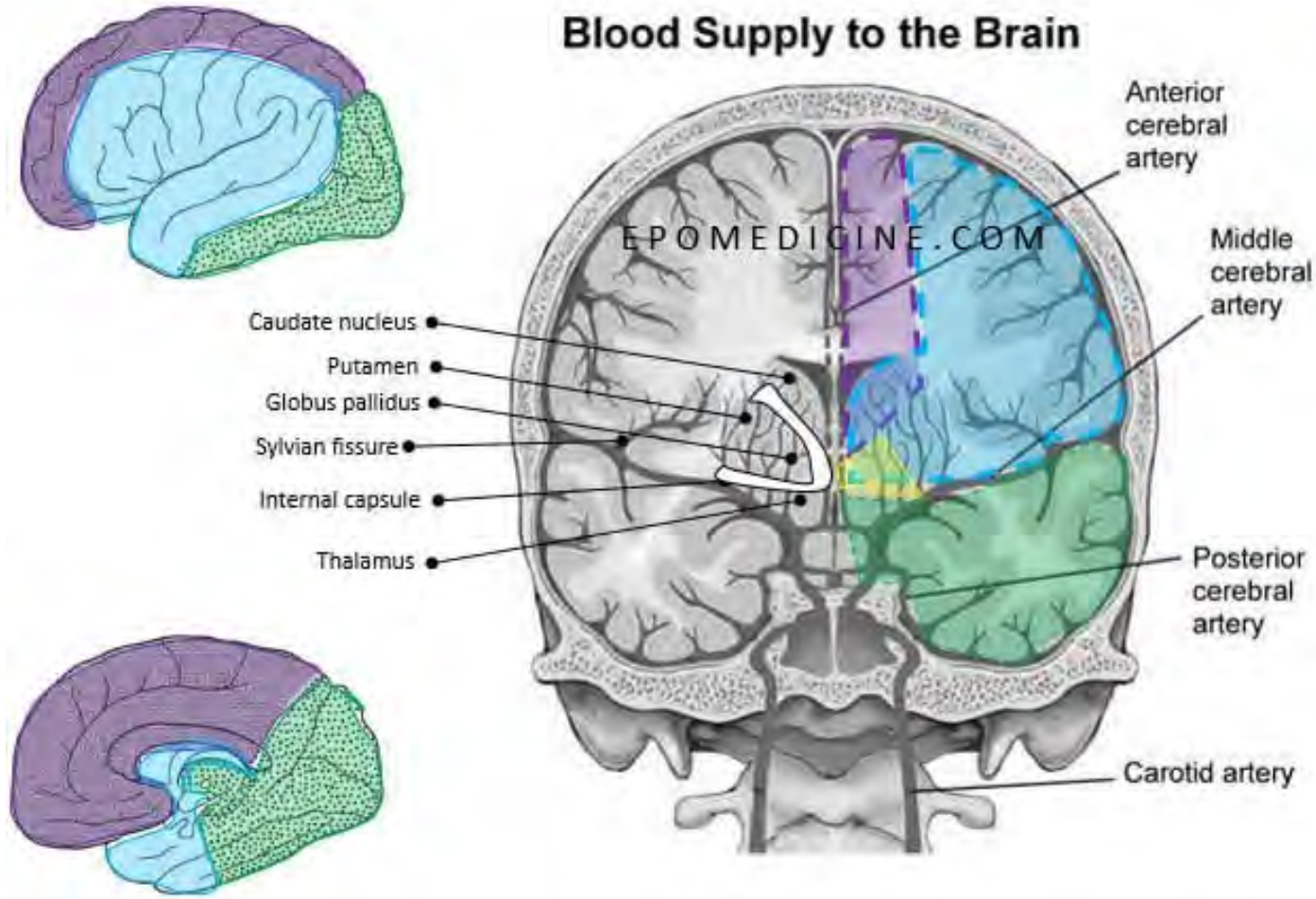


https://www.joeniekrofoundation.com/understanding/brain-basics/

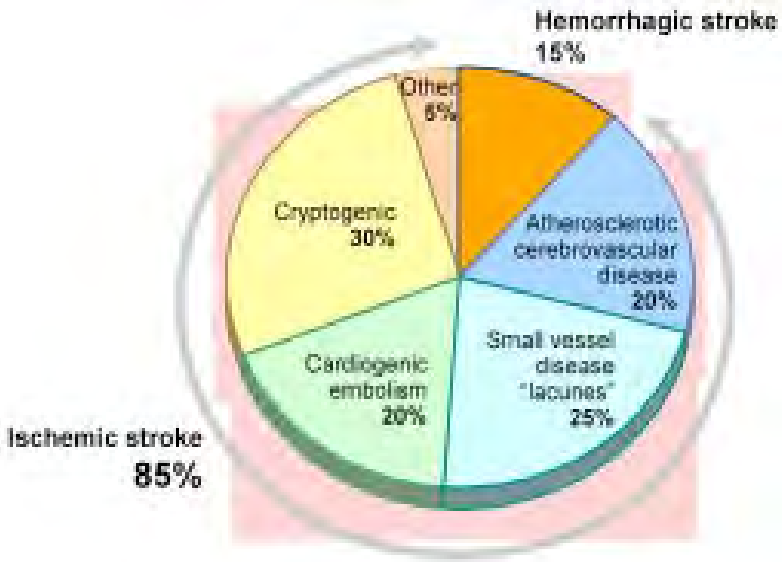


https://radiopaedia.org/articles/brain-arterial-vascular-territories?lang=us

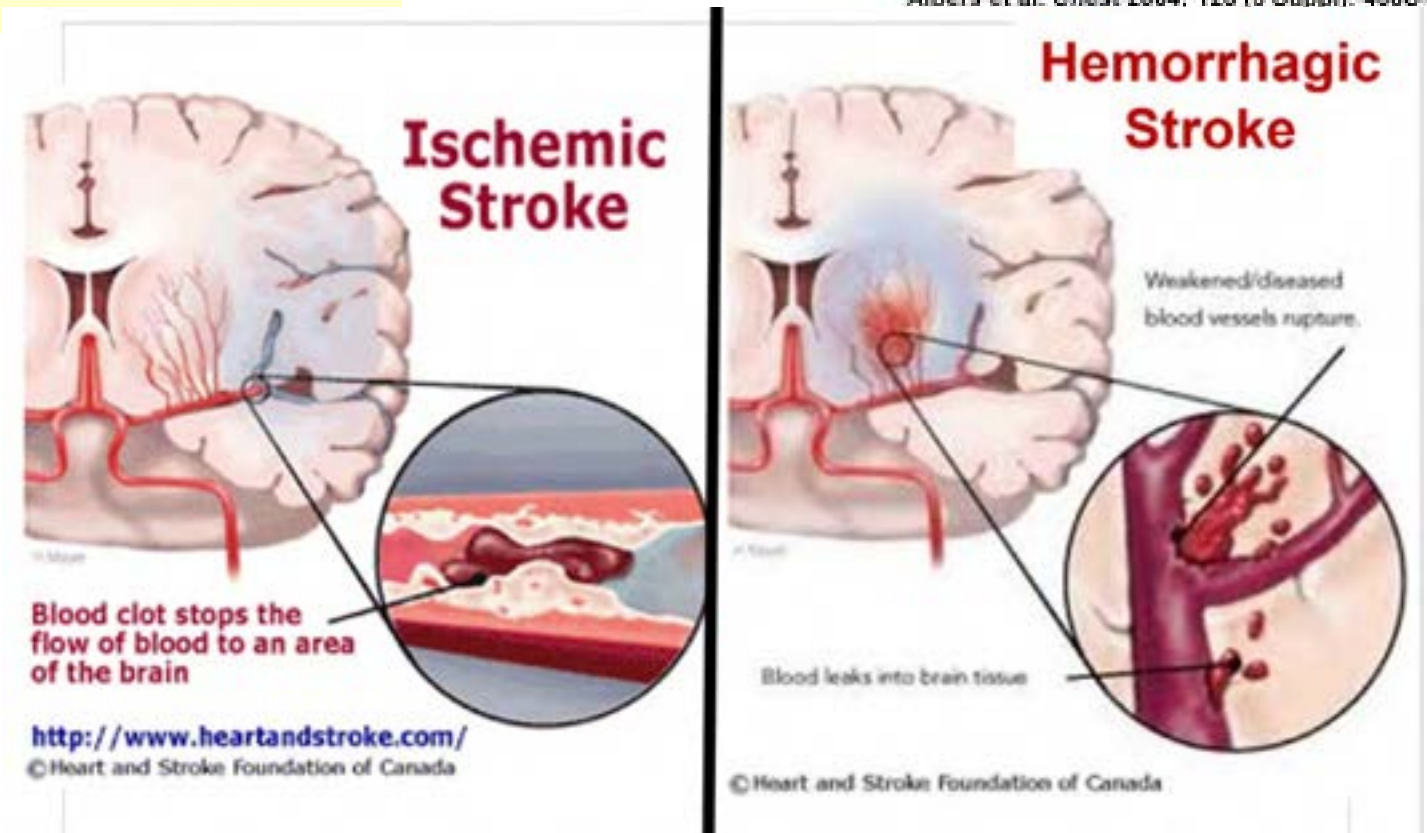
TYPES OF STROKE

Etiology

- **Ischemic** (80-85%)
  - Thrombosis
  - Embolism
- **Hemorrhagic** (15%)



Albers et al. *Chest* 2004; 126 (3 Suppl): 438S–512S.



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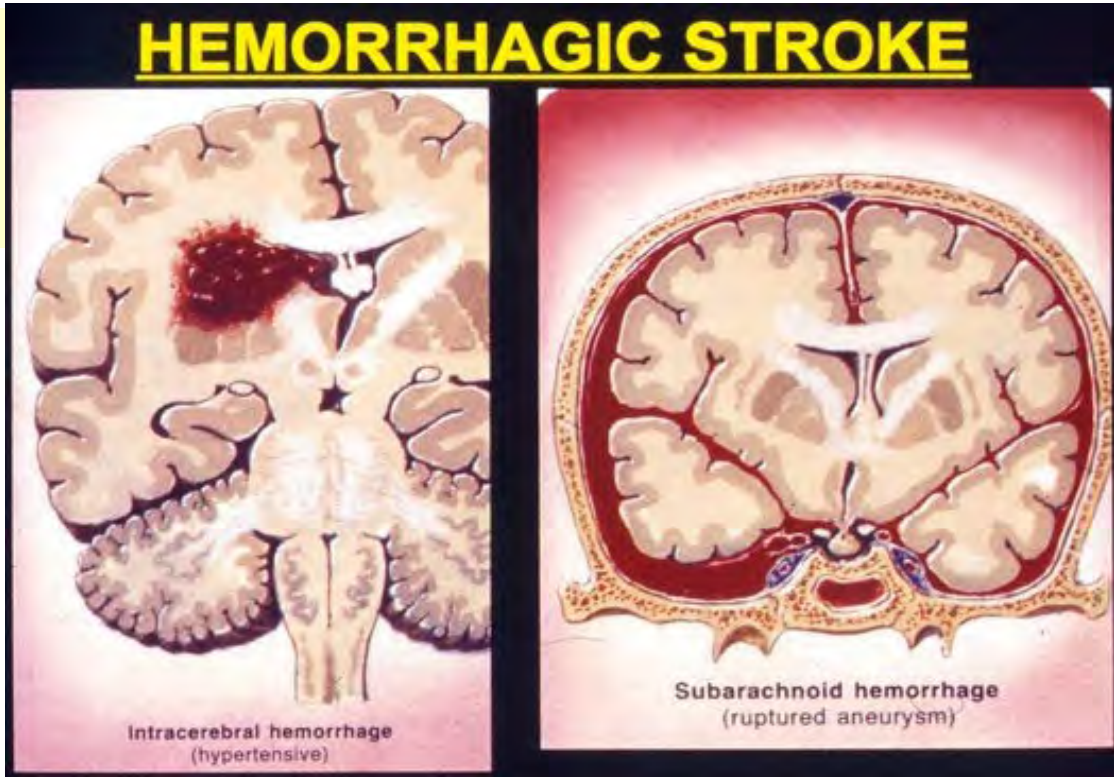
Hemorrhagic Stroke

- Intracerebral Hemorrhage
  - Hypertension
- Sub-arachnoid Hemorrhage
  - Ruptured aneurysm
- More likely present with symptoms of increased ICP
  - Nausea
  - Vomiting
  - Headache
  - Change in consciousness



- STAT head CT in ER to identify Hemorrhagic stroke
  - Treatment
    - Evacuation of the hemorrhage - Craniotomy
    - Observation (if small)

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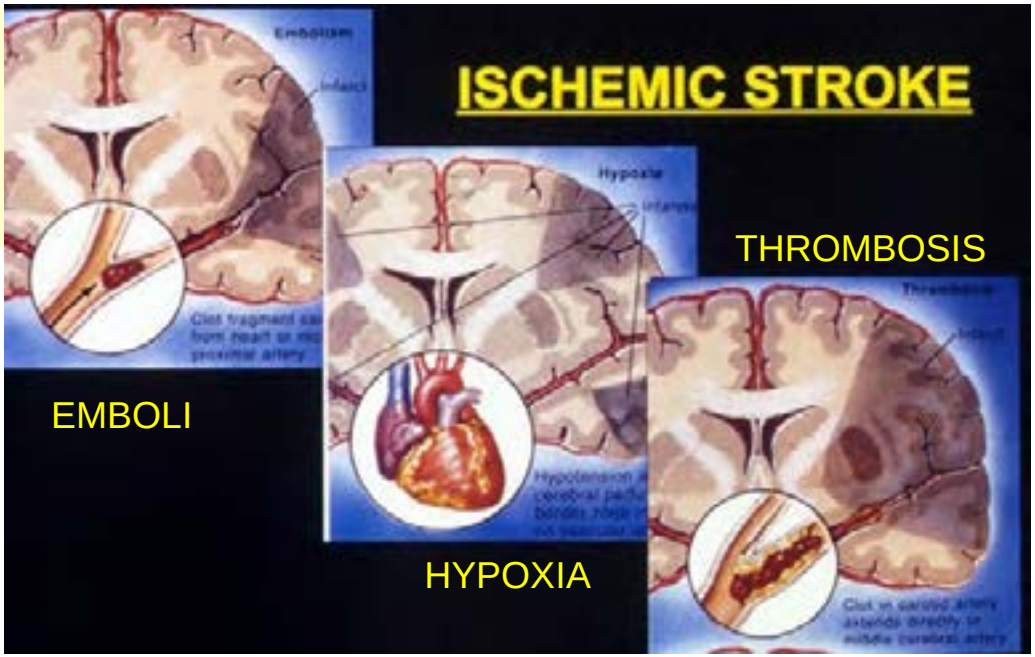
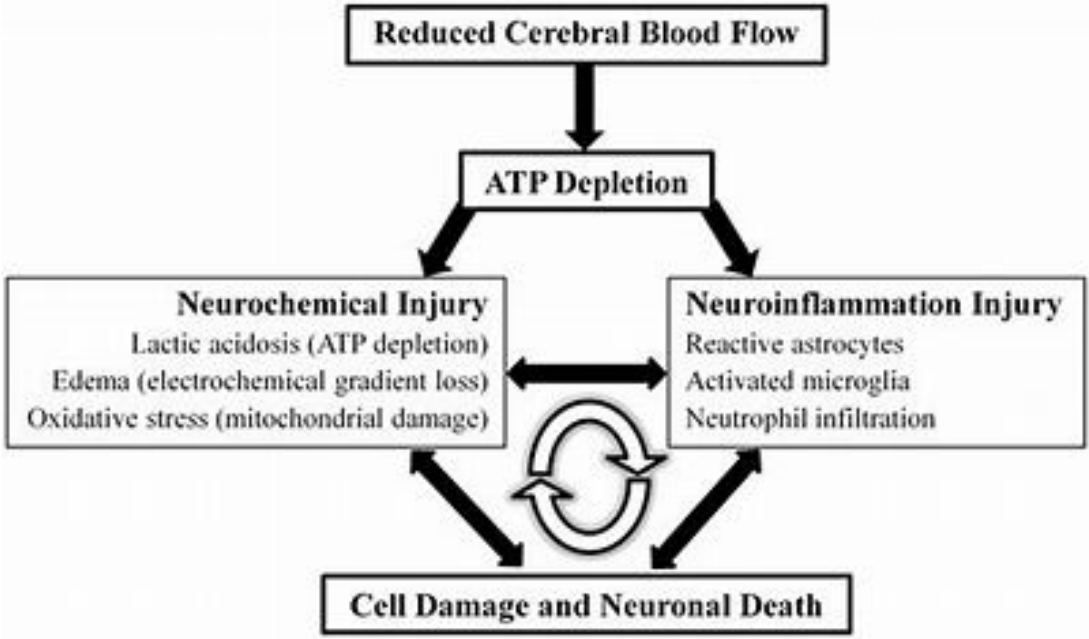
ISCHEMIC STROKE



- When an ischemic stroke occurs, the **blood supply to the brain is interrupted, and brain cells are deprived of the glucose and oxygen they need to function.**
- Within minutes, brain cells begin to die
- The ischemic area involved determines the type of focal deficit that is seen in the patient



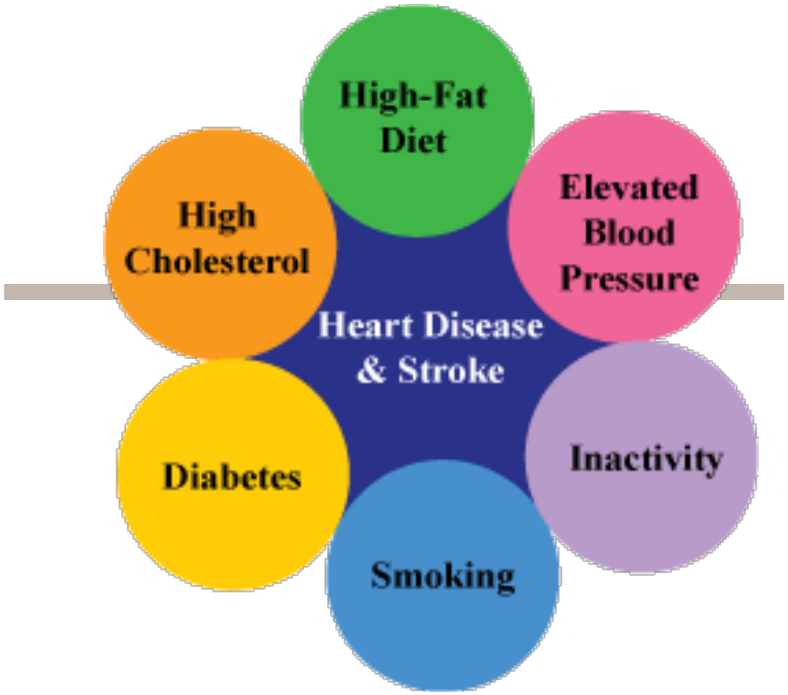
journal.frontiersin.org

Ischemic Stroke

- From Emboli
  - Mitral stenosis
  - Endocarditis
  - Myocardial infarction
  - Patent Foramen Ovale
  - Congestive Heart Failure
  - Atrial Fibrillation
- From Thrombus
  - Arterial stenosis
    - Atherosclerosis
  - Sickle cell anemia
  - Protein C deficiency
  - Hyperhomocysteinemia
  - Other hypercoagulable state

Other Ischemic Stroke Risk Factors

- Hypertension
- Diabetes
- Hypercholesterolemia
- Tobacco Use
- Sleep Apnea
- Poor Diet
- Lack of exercise



Educate!

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Stroke Prevention

We have a responsibility to educate patients about stroke prevention!

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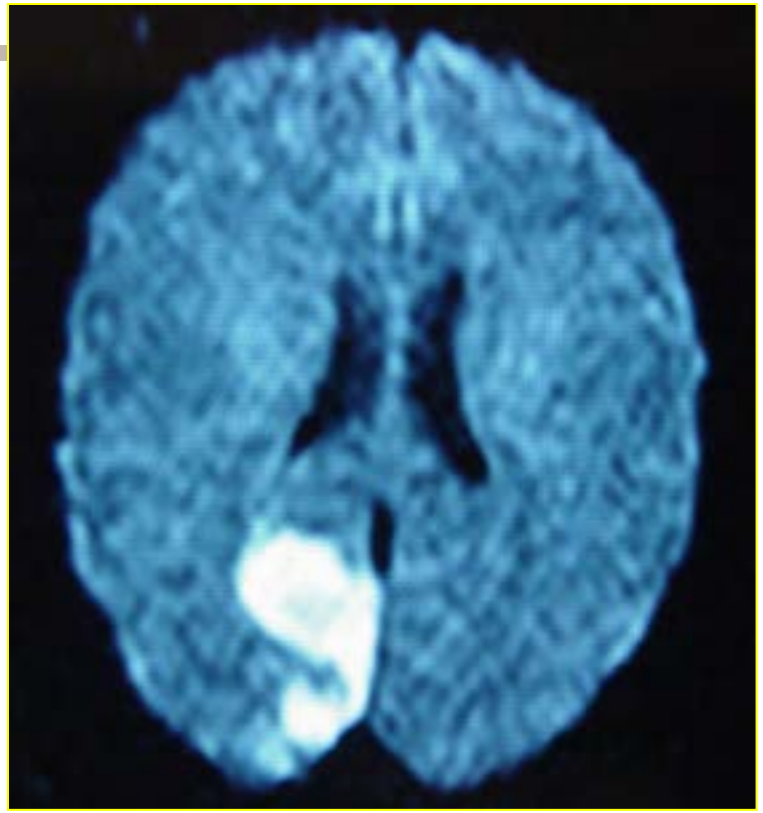
Stroke Work-Up

- Acute Stroke
  - To ER (with stroke center) ASAP
    - **Neuroimaging** - brain
      - CT – r/o hemorrhagic stroke
      - MRI with DWI and ADC
    - **Vascular imaging**
      - CTA/MRA – look at blood flow
      - Carotid Doppler US
    - **Cardiac evaluation**
      - EKG
      - Echocardiogram
        - Trans-thoracic (TTE)
        - Trans-esophogeal (TEE)
    - **Labs**
      - CBC, chem panel, hypercoagulable states, lipid panel, homocysteine, ESR, C-reactive protein, platelet count, (r/o GCA) etc.



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CASE 3
Stroke

67 year-old man

History of blindness OD x 7 yrs (RD)

HTN, hypercholesterolemia, gout

Meds: Diovan, indomethacin (ASA d/c c indo)

1-2 weeks ago noted sudden decreased vision OS

Seemed to be temporally OS

Some shortness of breath

No associated pain or other neuro symptoms (denies GCA symptoms)

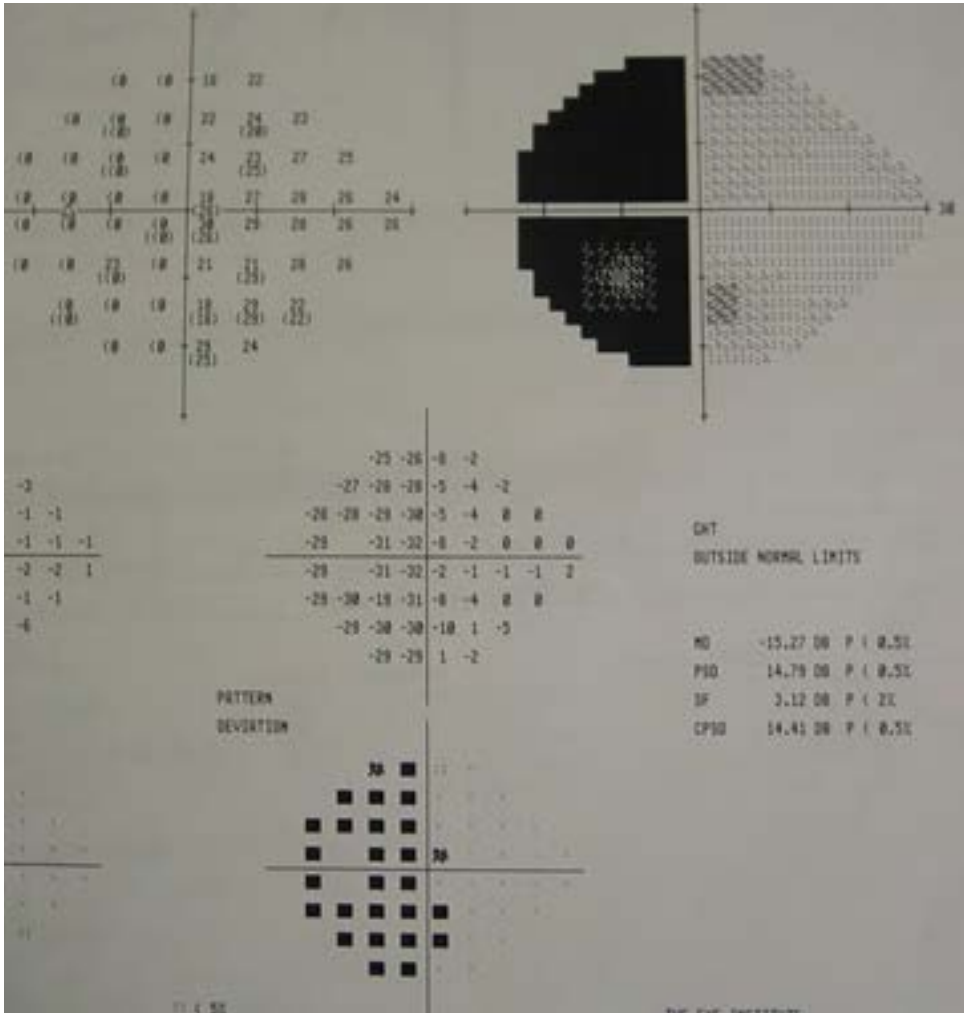
Vision improved somewhat in first day, but stable since

Saw PCP – did EKG – normal

Pt refused stress test

EXAM RESULTS

- VA OD NLP OS 20/25
- (+) RAPD OD
- BP 160/100
- Neurologic-exam:
  - Finger-to-nose ataxia
  - Difficulty with tandem gait



What do we think about this VF?

What could it indicate? 2 possibilities

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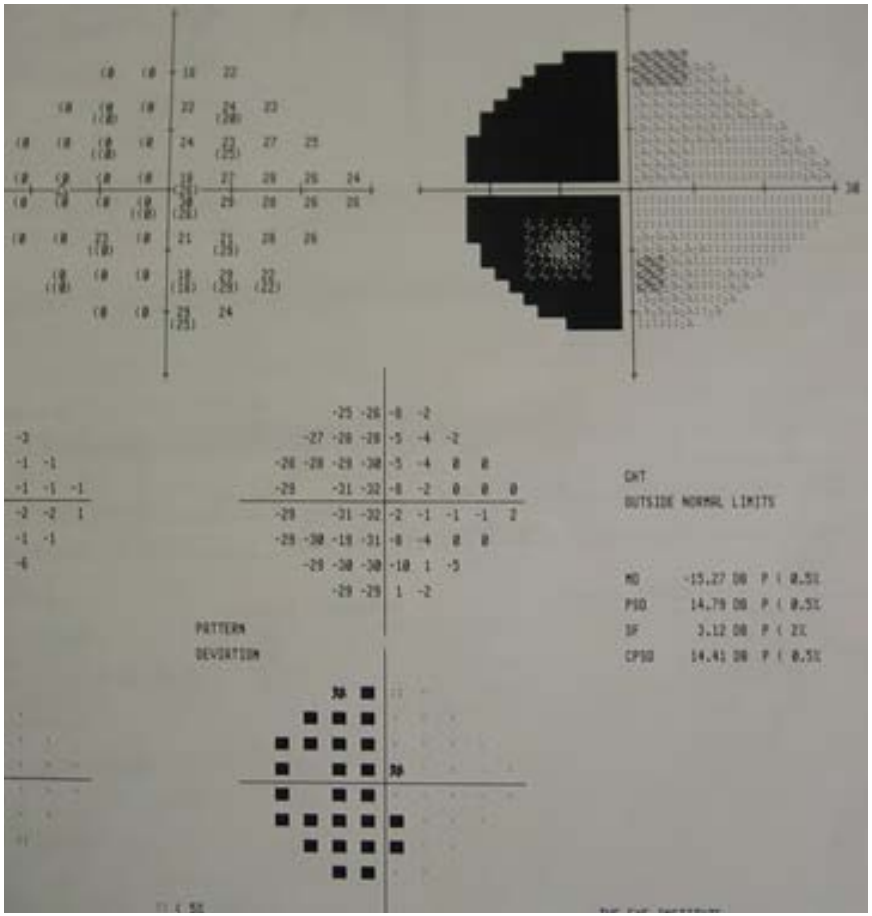
EXAM RESULTS

- VA OD NLP OS 20/25
- (+) RAPD OD
- BP 160/100
- Neurologic-exam:
  - Finger-to-nose ataxia
  - Difficulty with tandem gait



Bitemporal vs Homonymous

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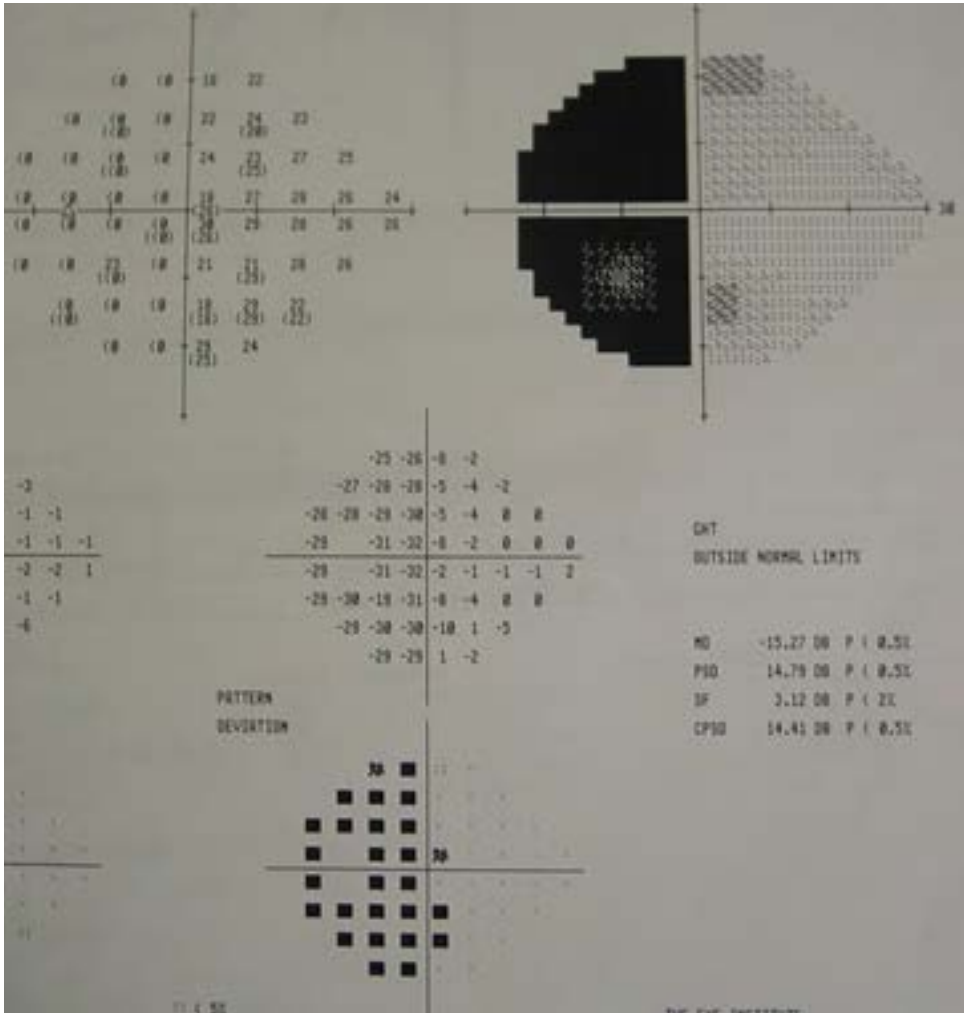
Sudden Vision Loss

- Bitemporal Hemianopia
  - PITUITARY APOPLEXY
    - Sudden infarct in or bleed of pituitary adenoma
      - Headache
      - Nausea
      - Vomiting
      - Vision loss
      - Can effect EOMS (cavernous sinus)
      - Hormone insufficiency
- Painful (usually)

- Homonymous Hemianopia
  - RETROCHIASMAL STROKE
    - Ischemic or hemorrhagic stroke
      - Optic tract
      - Lateral geniculate nucleus
      - Optic radiations
      - Occipital lobe (purely vision)
- Painless (usually)

EXAM RESULTS

- VA OD NLP OS 20/25
- (+) RAPD OD
- BP 160/100
- Neurologic-exam:
  - Finger-to-nose ataxia
  - Difficulty with tandem gait



Where does this localize?

What do we need to do?

How urgent is this?

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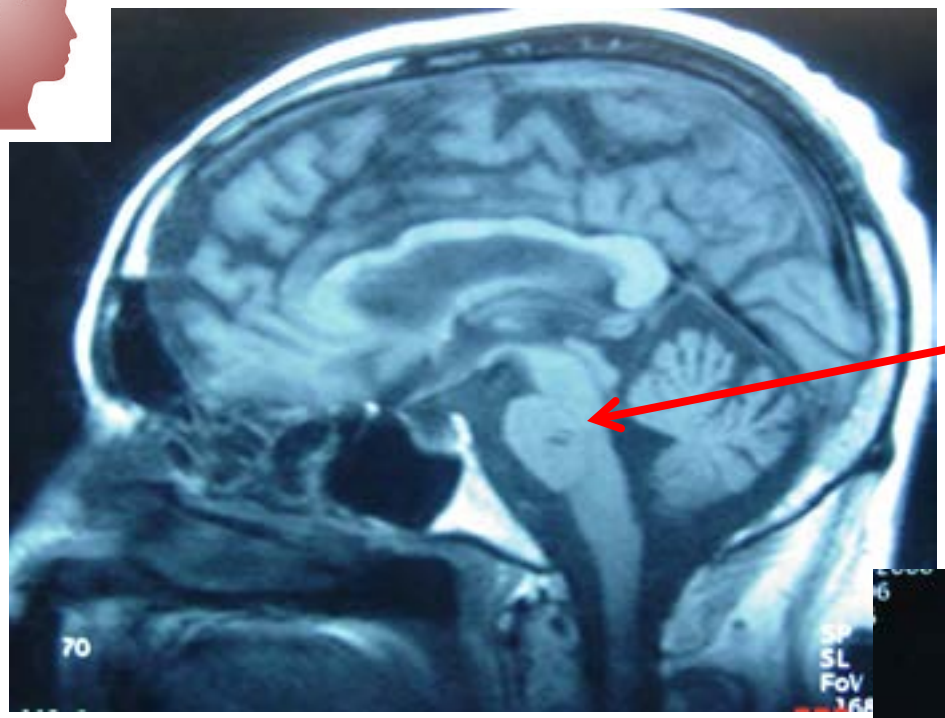
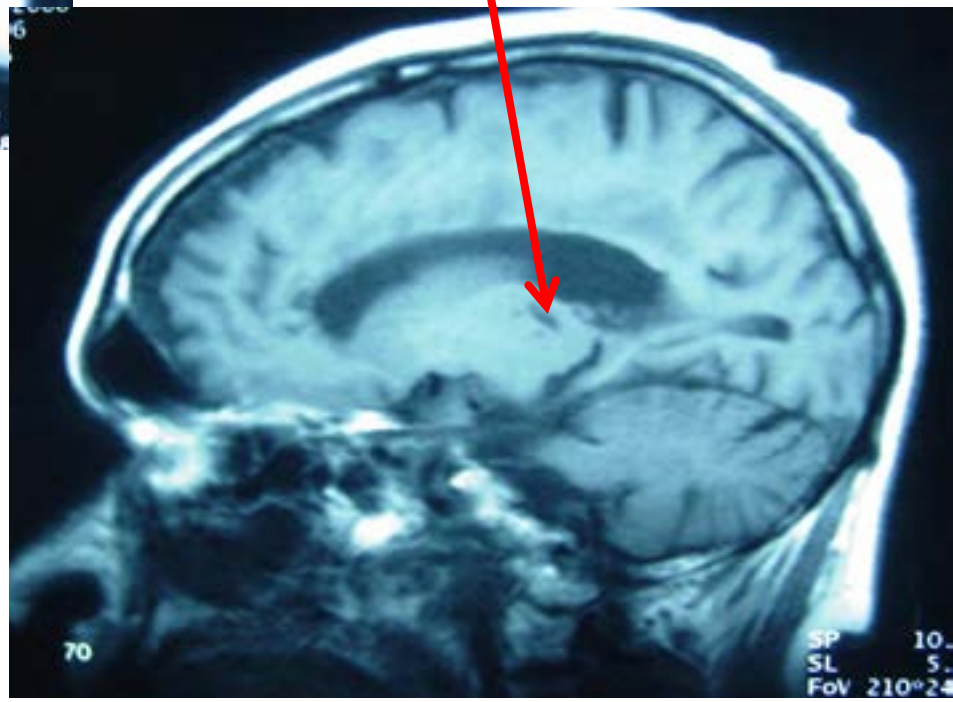
Neuroimaging!!

MRI brain without contrast

MRA head without contrast



Old lacunar infarcts in pons and thalamus



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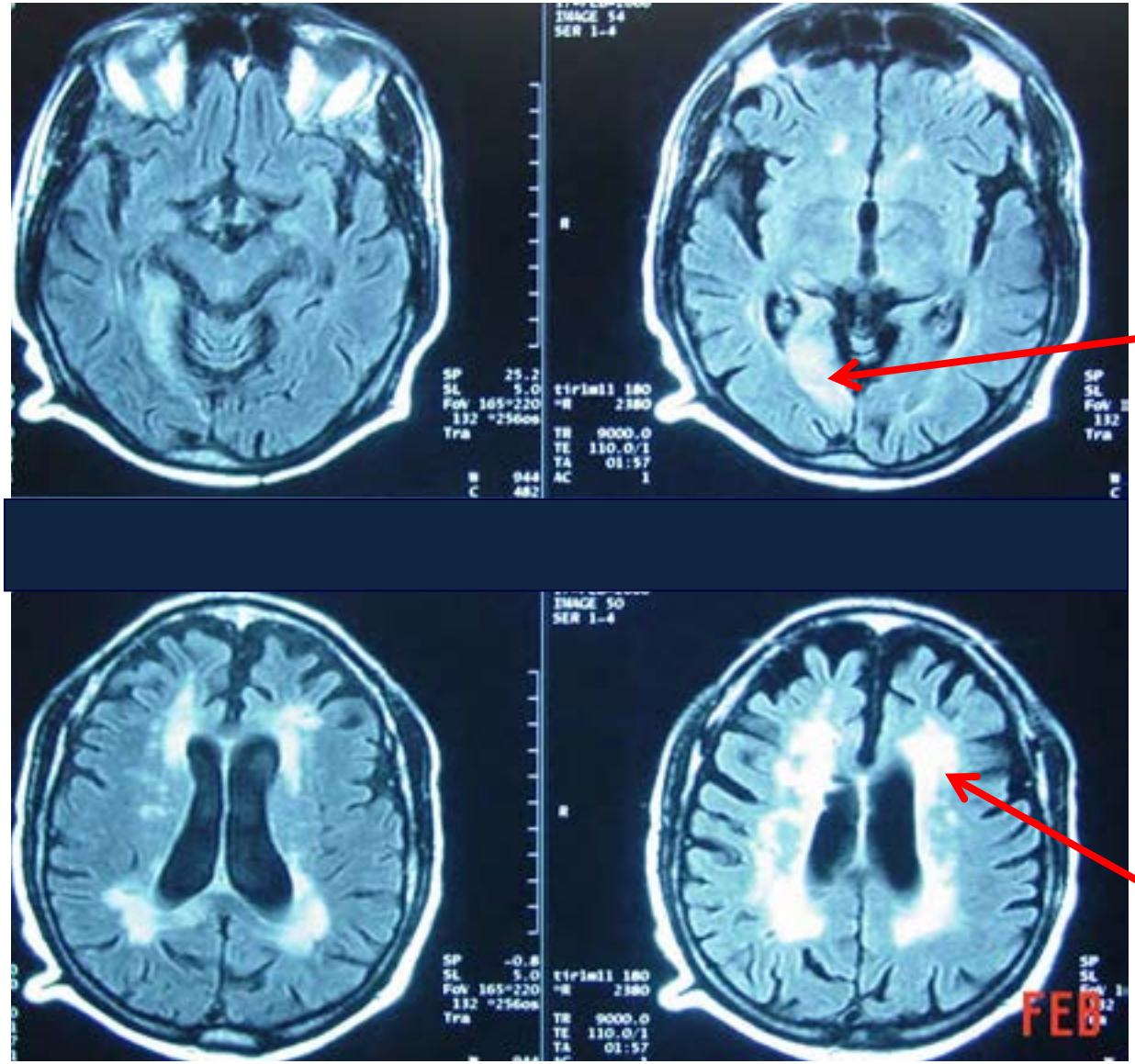

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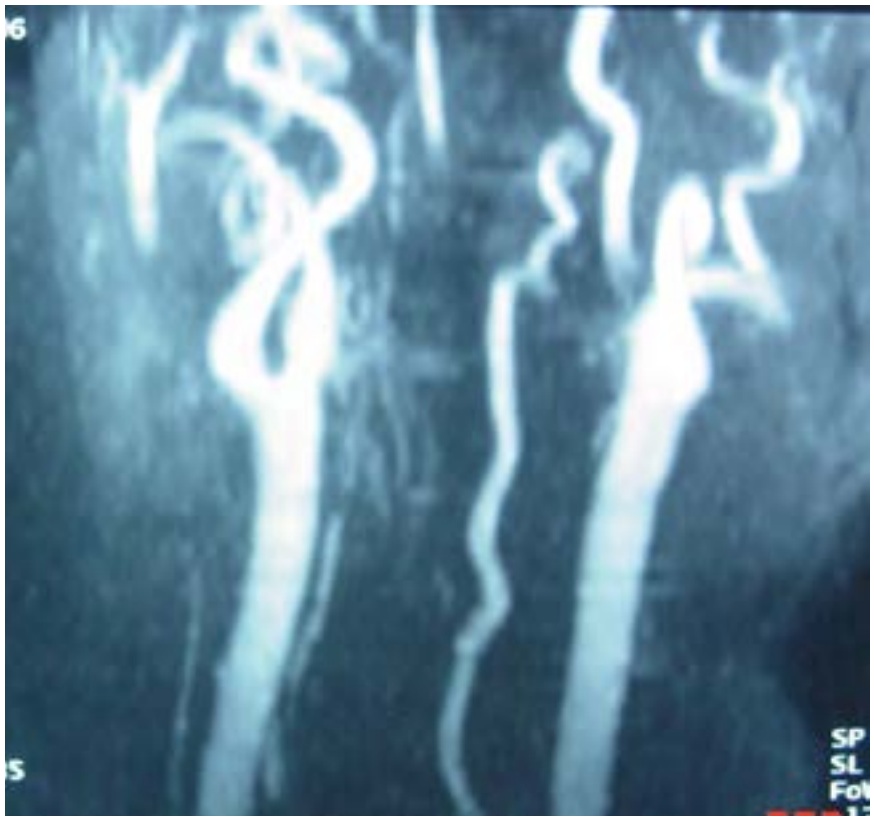
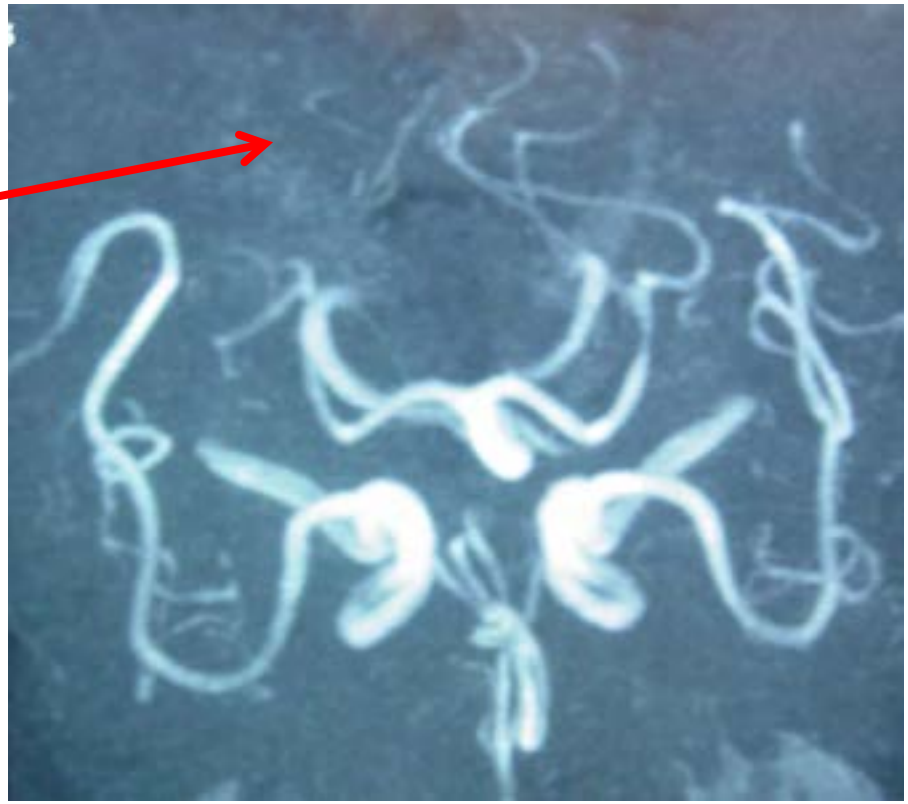
MRA: Lack of flow in right PCA





ESR mildly elevated at 39 (age 67);
CRP normal
Homocysteine level elevated at 27
Normal level (4.0 – 15.4)

TREATMENT:
Folic Acid
Re-initiate ASA 81 mg
Stroke neurology consult

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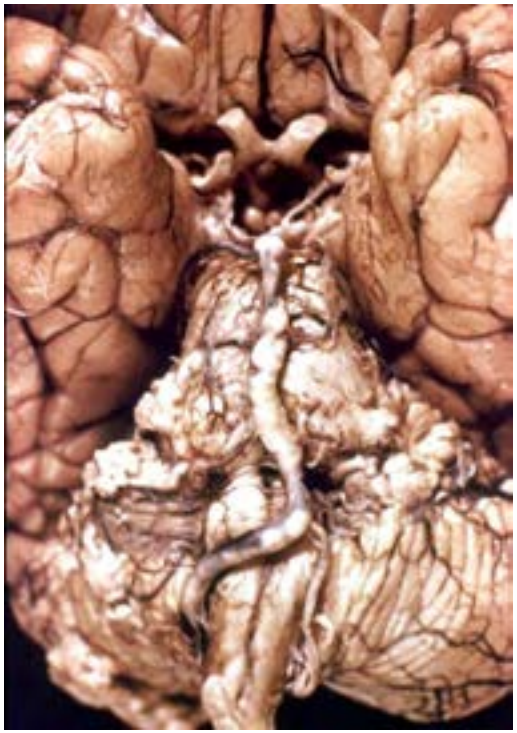
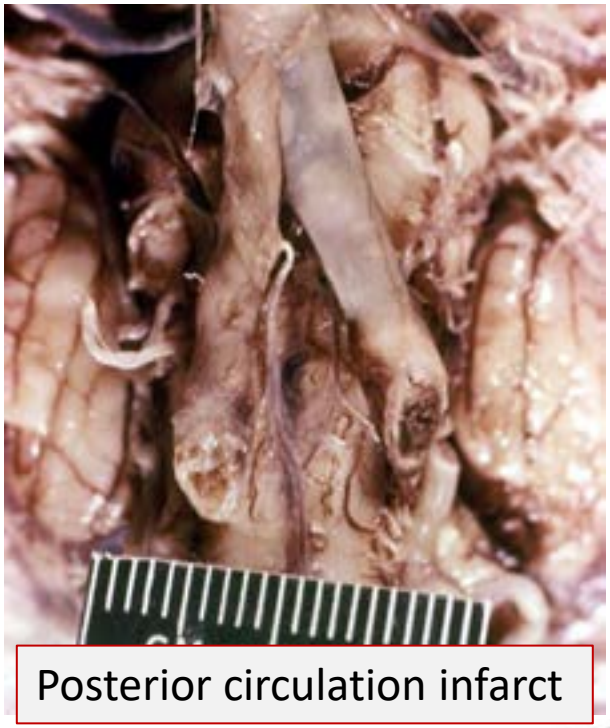
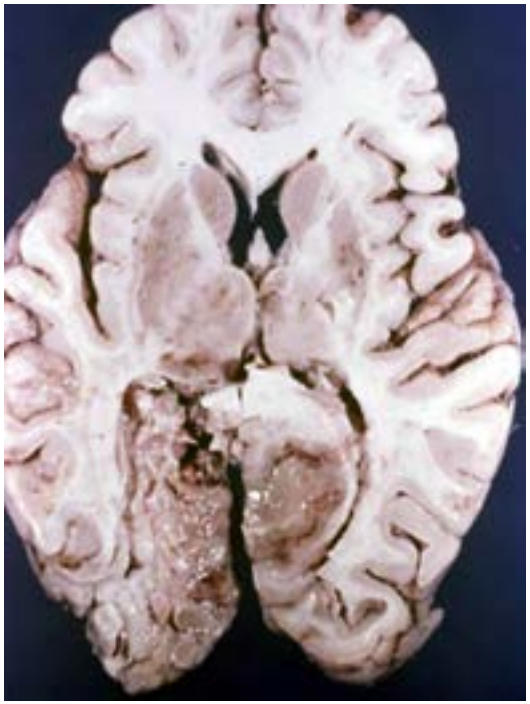
Occipital Lobe Ischemic Infarct

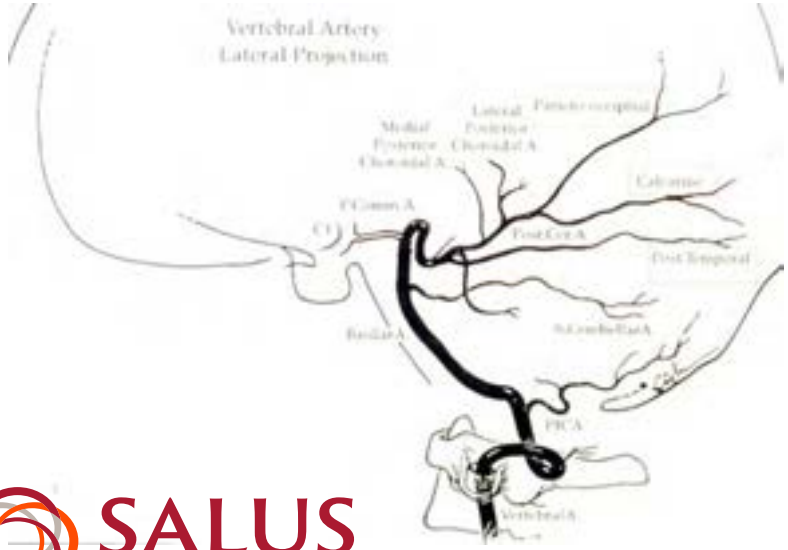
- POSTERIOR CIRCULATION ABNORMALITY
  - Occlusion of Posterior Cerebral Artery
    - Emboli in PCA
    - Emboli from distant site
      - Distant vessels (basilar, vertebrals, even carotid in some cases)
      - Heart
    - Thrombus

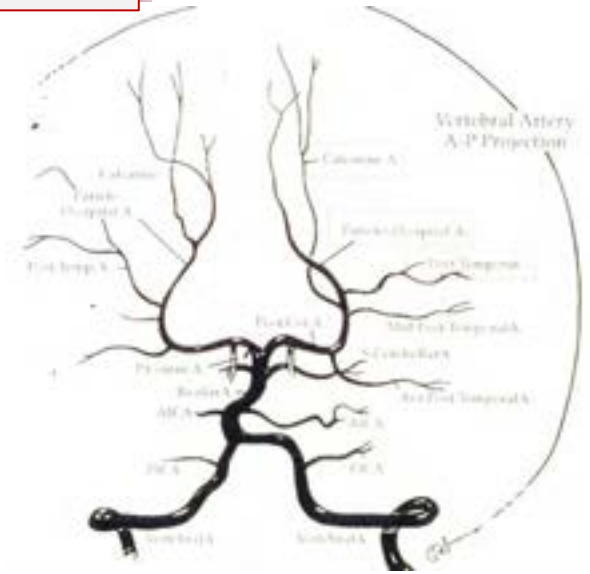




Posterior circulation infarct







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PANEL DISCUSSION

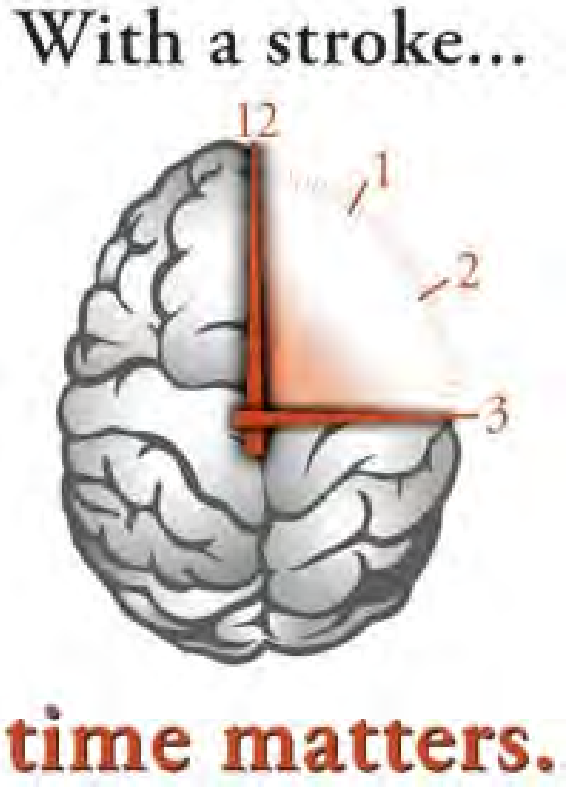
ACUTE STROKE = MEDICAL EMERGENCY!

Do not complete eye exam

Only do what you need to confirm your stroke suspicion

Call 911 immediately

Tell the dispatcher the patient has had an acute stroke

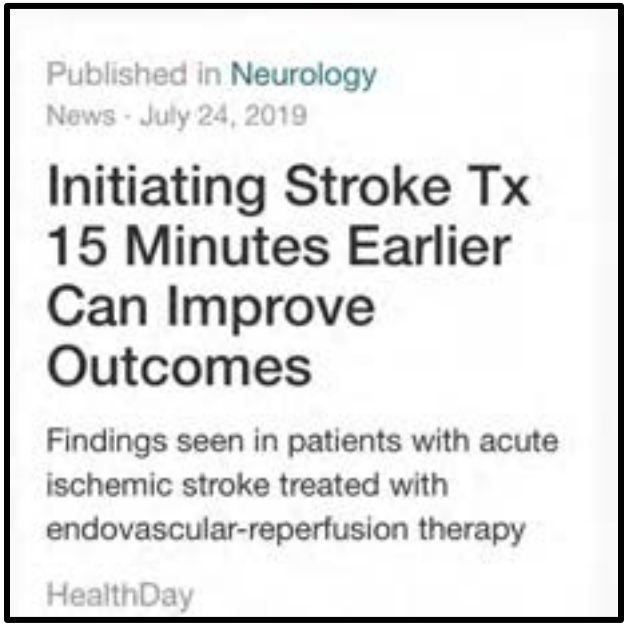


Time is Brain!

(for BOTH ischemic and hemorrhagic stroke)

Time to brain death based on % normal blood flow

% NORMAL BLOOD FLOW	TIME TO BRAIN DEATH
NO flow	10 minutes
<30% normal flow	1 hour
30-40% normal flow	Hour to several hours
With collateral and residual flow	Up to 6 hours



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Get The Patient to the RIGHT ER

- If possible - **Advanced Comprehensive Stroke Center**
- This differs from an Advanced PRIMARY Stroke Center

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Door to treatment in ≤60 min[17,18]

0 min
Suspected stroke patient arrives at ED

≤10 min
Initiate MD evaluation, including patient history and time last known well/symptom onset
Initiate labwork
Assess using NIHSS

≤15 min
Notify stroke team (including neurologic expertise)

≤25 min
Initiate CT scan

≤45 min
Interpret CT scan and labs
Review patient eligibility for Activase

≤60 min
Give Activase bolus and initiate infusion in eligible patients*

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rt-PA (thrombolysis)

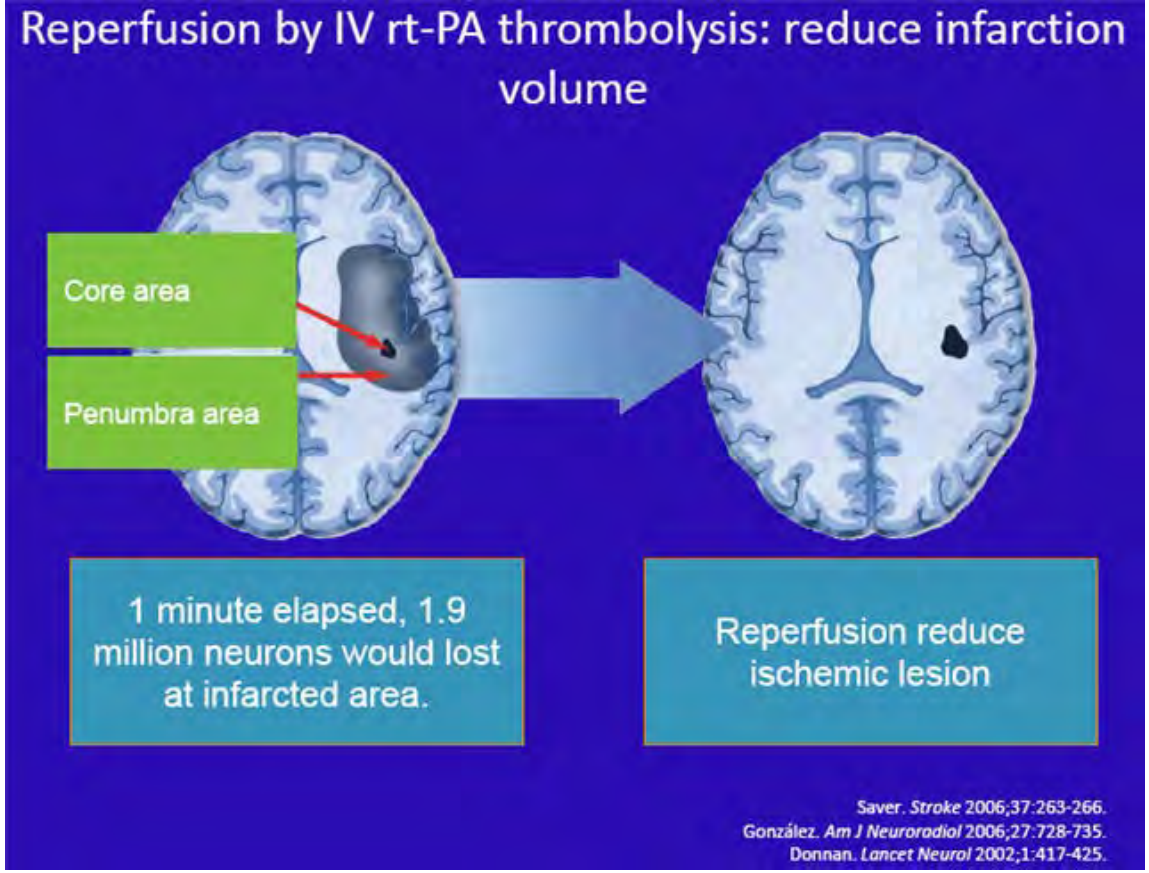
National Institute of Neurologic Disorders and Stroke (NINDS)

1992: Recombinant tissue type plasminogen activator (rt-PA) study group. FDA approval in 1996.

Early administration of t-PA benefited pts with acute ischemic stroke (= **MEDICAL EMERGENCY)**

Initially benefit of t-PA thought to occur in 3 hour window from onset of stroke symptoms. Window was later extended to 4.5 hours (8 fold improvement of ischemic stroke outcomes)

Risk of rt-PA: Hemorrhage (5.2%)



Effective in ¼ to 1/3 of patients

If patients are not candidates, the time frame (4.5 hr – sometimes more) has passed, or the treatment was ineffective, there is now another alternative treatment option…

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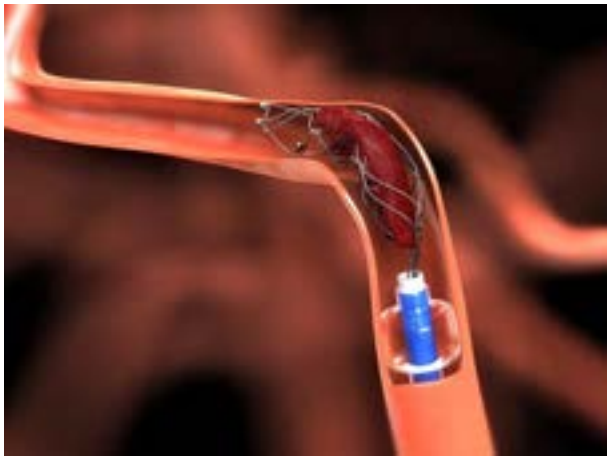
The Stent Retriever

Used primarily at advanced comprehensive stroke centers



- Tiny wire cage
- Threaded through a catheter into a blood vessel in the groin
- Guided up to the blocked artery in the brain
- Cage opens up and captures the clot
- The stent, along with the clot, is removed
- Immediately blood begins flowing again to the brain

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Transient Ischemic Attack (TIA)

- Neurologic deficit that resolves within 24 hours
- 80% resolve within 1 hour
- 10% of pts with TIA go on to have a stroke in 90 days

- TIA = temporary (includes transient vision loss)
- Stroke = permanent (includes CRAO and BRAO)
- NEED TO BE TREATED THE SAME!!

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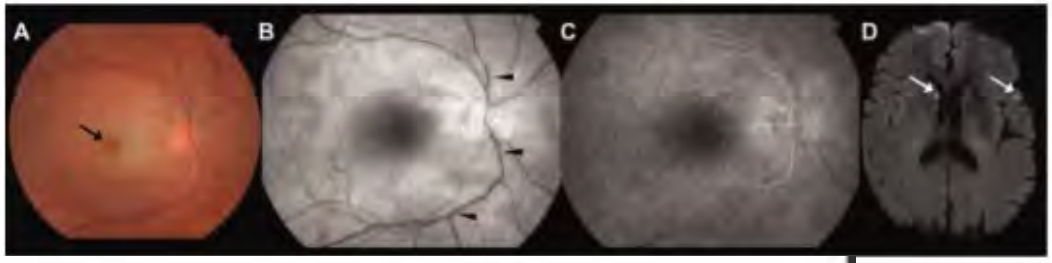
In terms of management, TIA = STROKE

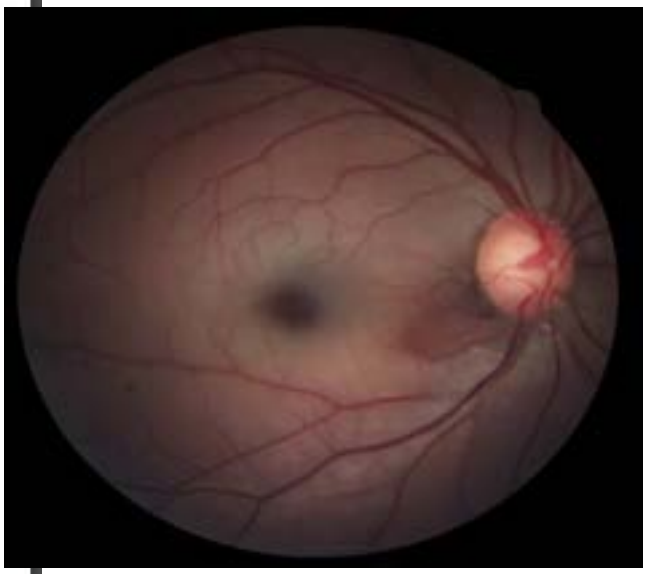
Retinal ischemia vs cerebral ischemia

Concurrent Acute Brain Infarcts in Patients with Monocular Visual Loss

Johanna Helenius, MD,[1] E. Murat Arsava, MD,[1] Joshua N. Goldstein, MD, PhD,[2]
Dean M. Cestari, MD,[3] Ferdinando S. Buonanno, MD,[4]
Bruce R. Rosen, MD, PhD,[1] and Hakan Ay, MD[1,4]

ANN NEUROL 2012;72:286–293





American Journal of Ophthalmology
June 2014; 157: 1119–1121

EDITORIAL

Acute Retinal Arterial Ischemia: An Emergency Often Ignored

VALÉRIE BIOUSSE

- SAME MECHANISMS!
- SAME Guidelines for
  - Stroke
  - TIA
  - CRAO
  - BRAO
  - Transient vision loss

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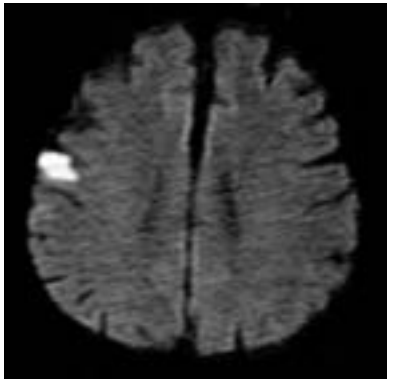
What's the hurry?

Co-occurrence of Acute Retinal Artery Occlusion and Acute Ischemic Stroke: Diffusion-Weighted Magnetic Resonance Imaging Study

JUNWON LEE*, SEUNG WOO KIM*, SUNG CHUL LEE, OH WOONG KWON, YOUNG DAE KIM, AND SUK HO BYEON

Am J Ophthalmol 2014; 157: 1231-1238



¼ of patients with acute retinal ischemia (even if transient) had an acute brain infarction on brain DWI-MRI

10-15% of patients will have a disabling stroke within 3 months after a TIA, with half occurring within 48 hours after resolution of TIA.

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AHA/ASA Guideline

Guidelines for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Any patient with suspected TIA or those with acute retinal ischemia should be evaluated urgently in order to identify those at high risk of immediate cerebral infarction and cardiac ischemia.

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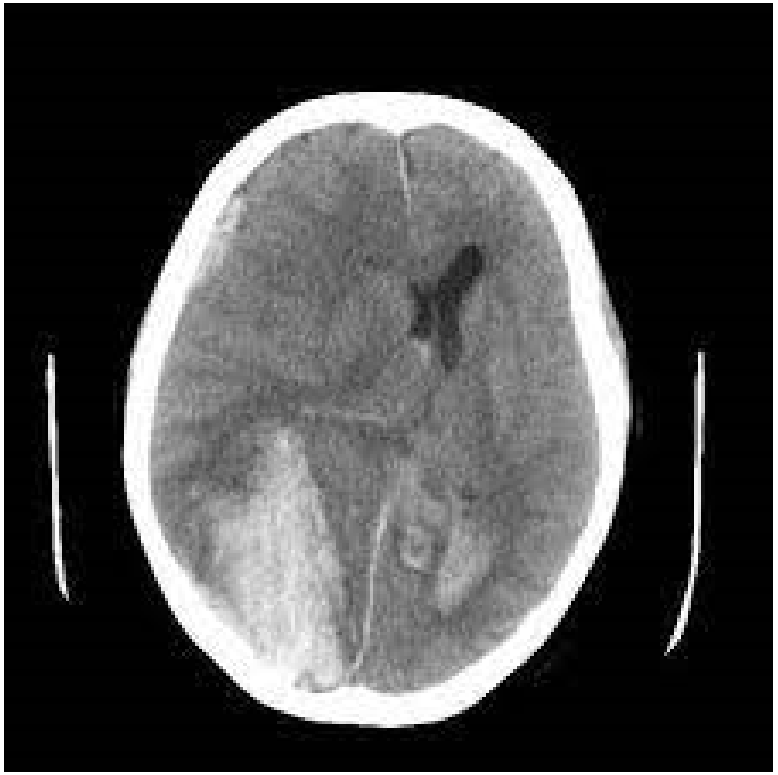
Do NOT send these patients to their PCP, cardiologist, neurologist, neuro-ophthalmologist, or retinal specialist.

Do NOT try to obtain the work-up yourself.

Send to an ED with an Acute Stroke Care Center!

CT Necessary First to R/O Hemorrhagic Stroke

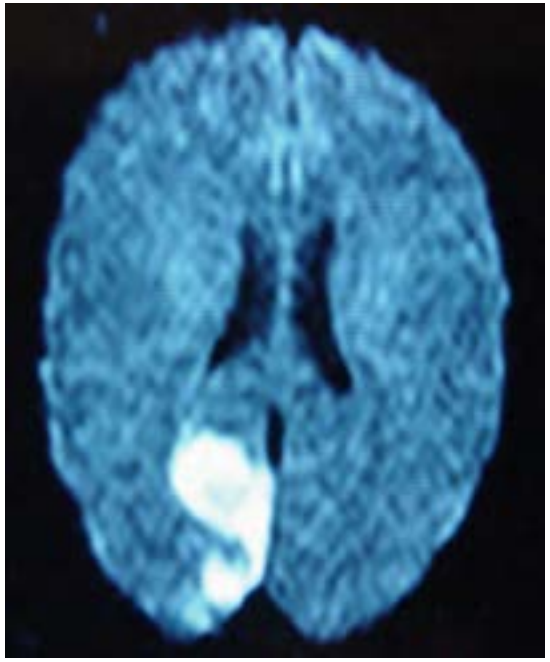


https://radiopaedia.org/articles/intracerebral-haemorrhage

If no hemorrhagic stroke seen, then MRI is necessary, but with certain sequences that are best at detecting acute infarcts

MRI - Diffusion Weighted Imaging (DWI)

- Very fast recovery time (few msec)
- Used to diagnose ACUTE INFARCTS



-Bright area = acute stroke

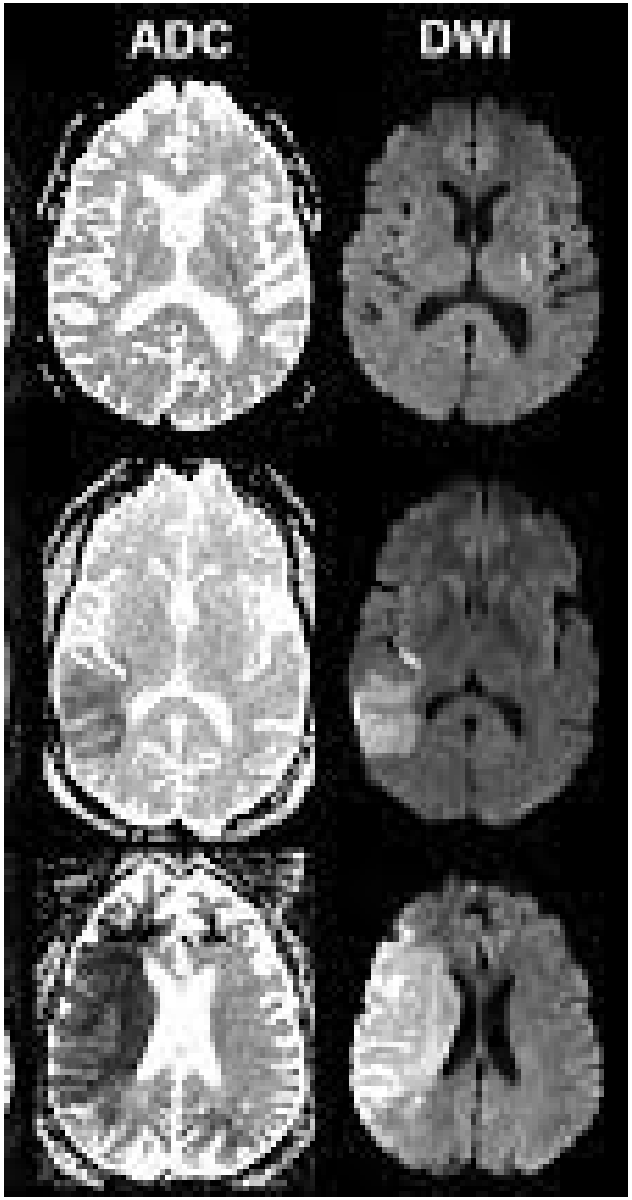
-Be aware of normal areas of artifact

-Sensitive to recent changes in vascular perfusion

ADC Map
Apparent Diffusion Coefficient

- Apparent Diffusion Coefficient has become an important diagnostic aid to DWI.
- ADC is the post processing of DWI.
- ADC maps are usually looked at with more credibility than DW images because there could be T2 shine-through on the DW images. T2 shine-through means the fluid that would normally be bright on a T2 weighted image could appear bright on a DWI since the DWI is usually T2 weighted.

	Restricted Diffusion of molecules	Normal Diffusion of molecules
DWI	**Bright**	Dark
ADC	**Dark**	Bright

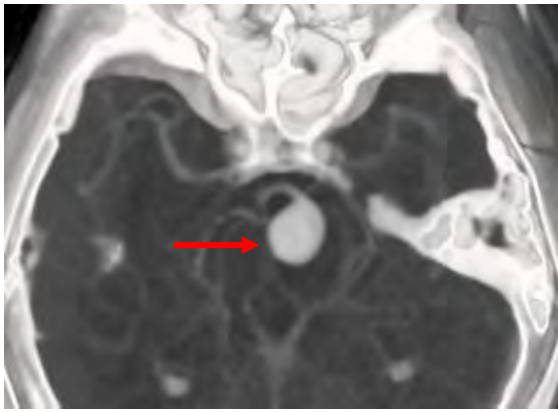


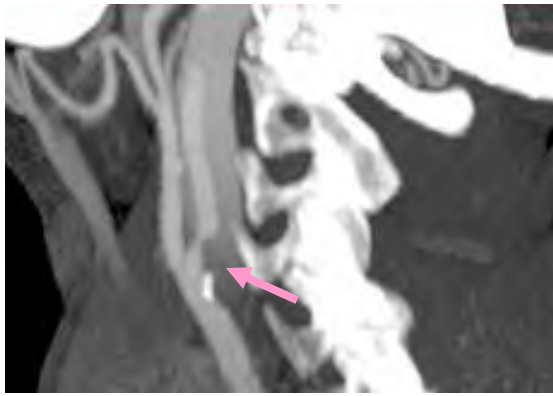
http://www.ajnr.org/content/40/6/938/tab-figures-data

CT Angiography (CTA)

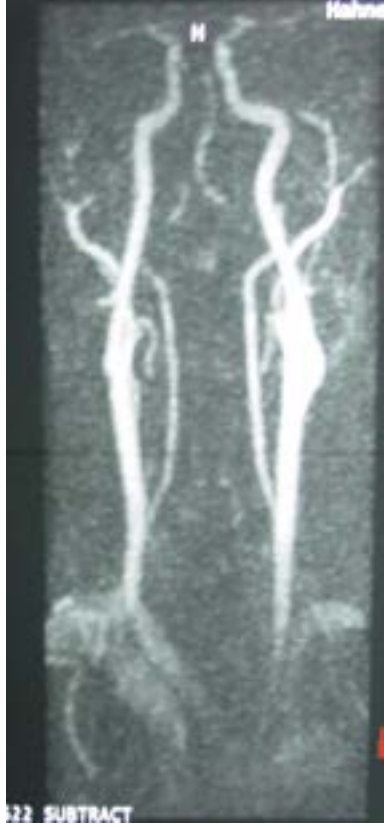
Contrast IS necessary

- View arteries of head (COW) and neck (carotids, vertebrals)
- Can view as cross-section or in 3D
- Look for aneurysms, AVMs, stenosis

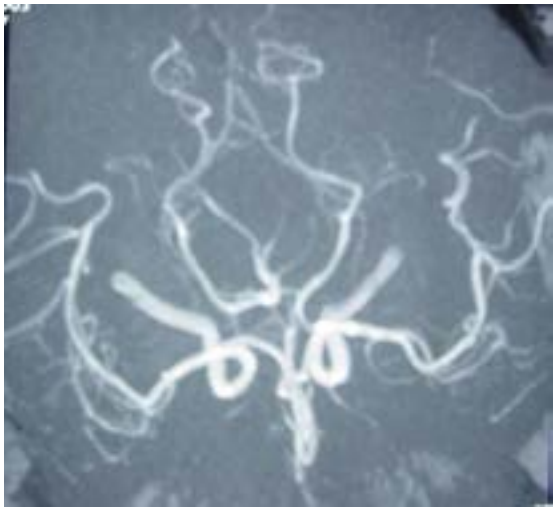




MRA (head / neck)



- **Contrast NOT necessary**
- View arteries of head (COW) and neck (carotids, vertebrals)
- Image is obtained by flow voids in vessels
- Vessels are normally dark due to movement of blood
- Series of acquisition images are used
- Look for aneurysms, AVMs, stenosis



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Kathy Discussion regarding stroke rehab (some suggestions)

- Time for possible recovery (up to one year)
- Rehabilitation considerations
  - Use of prism for complete homonymous hemianopsias
  - Use of prisms for CN palsies, INO, skew deviation, etc

Ocular Manifestations of Stroke / TIA (even if transient)

- Anterior Circulation
  - Amaurosis Fugax
  - CRAO / BRAO
  - Ocular Ischemic Syndrome
  - Carotid Artery Dissection
  - Visual Field Neglect
  - Supranuclear Gaze Palsy
- Posterior Circulation
  - Brainstem Motility Disorders
    - INO
    - Skew Deviation
    - Dorsal Midbrain Syndrome
  - Homonymous Hemianopia
  - Disorders of Visual Association Cortex
  - Nystagmus

HOMONYMOUS HEMIANOPIA
Prognosis

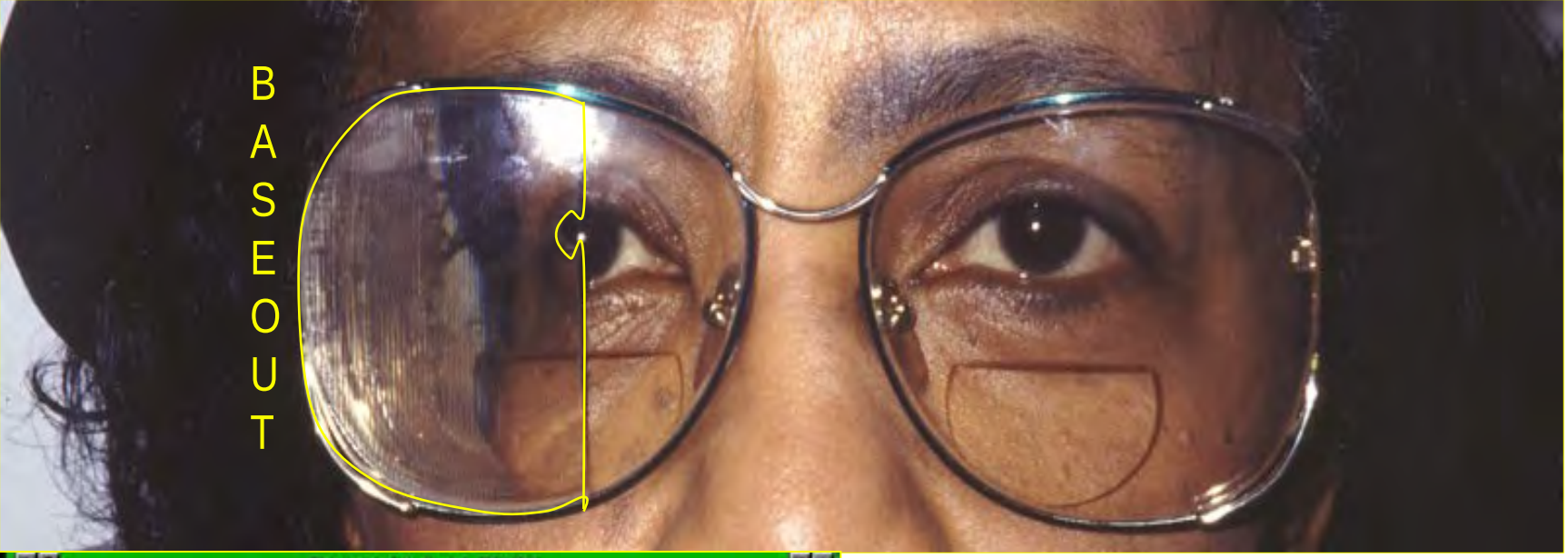
(Messing B, Ganshirt Neuro-oph 1987)

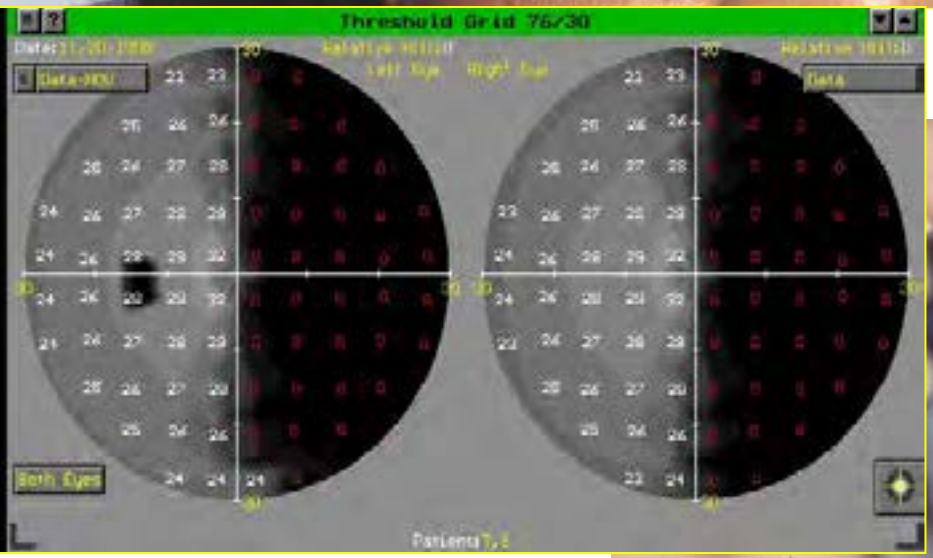
- Can improve as edema resolves
  - 84% have some amount of recovery at 6 months
  - Allow 1 year to get to maximum recovery
    - » Usually not enough recovery to regain driving ability in those not meeting visual driving requirements right after stroke

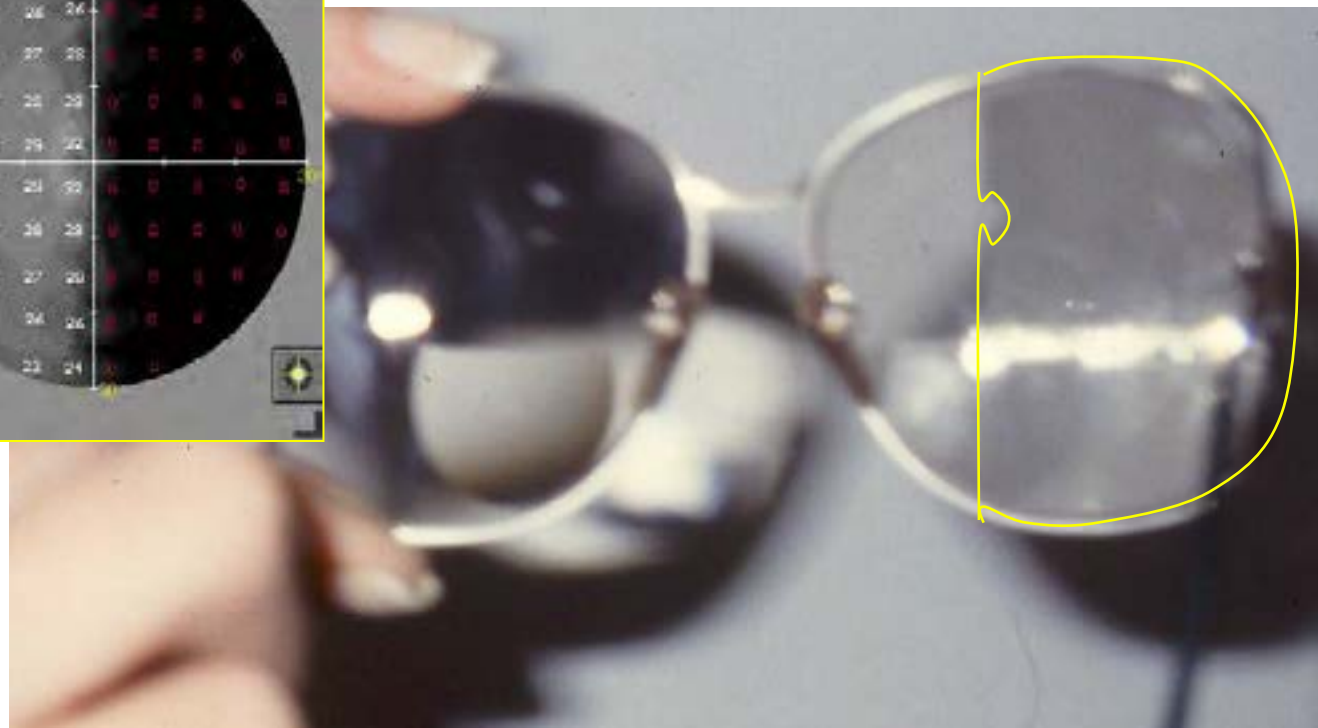
24-3 or 30-2 HVF are NOT good enough to assess driving ability. Need to do Binocular Esterman VF or Goldmann VF.

HOMONYMOUS HEMIANOPIA VISUAL REHABILITATION

- 30-40 PD FRESNEL PRISM
- BASE OUT to HEMIANOPIC DEFECT
- SPLIT FIXATION
- BEST CANDIDATES ARE *ISOLATED* & *COMPLETE* LEFT HOMONYMOUS
- 2 WEEK TRIAL


BASEOUT


Threshold Grid 76/30
Both Eyes



Neurdegenerative Disease Background Information

NEURODEGENERATIVE DISEASE

- A group of conditions that affect neurons in the brain
- Since neurons can not normally regenerate or reproduce themselves, when they become damaged, it is irreversible
- Neurodegenerative diseases are both incurable and debilitating

- Alzheimer's Disease
- Parkinson's Disease
- Progressive Supranuclear Palsy (PSP)
- Multisystem Atrophy (MSA)
- Amyotrophic Lateral Sclerosis (ALS)
- Multiple Sclerosis (MS)
- Neuromyelitis Optica (NMO)
- Huntington's Disease
- Prion Disease
- Spinocerebellar Ataxia (SCA)

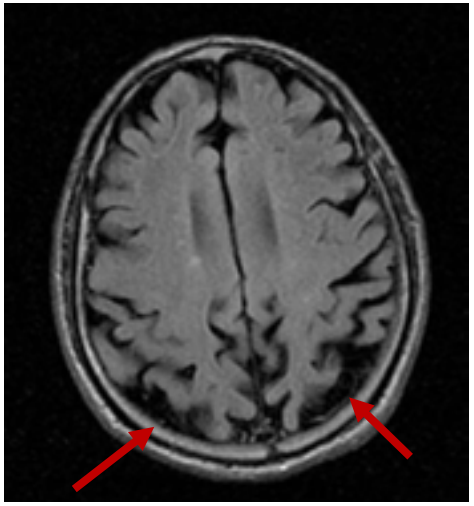
…and more

Alzheimer's Disease

- Progressive neurodegenerative disease
- **Predominantly a disorder affecting memory**
- As the disease progresses, can affect
  - Orientation
  - Attention
  - Language
  - Executive function
  - Visuospatial

Posterior Cortical Atrophy (PCA)

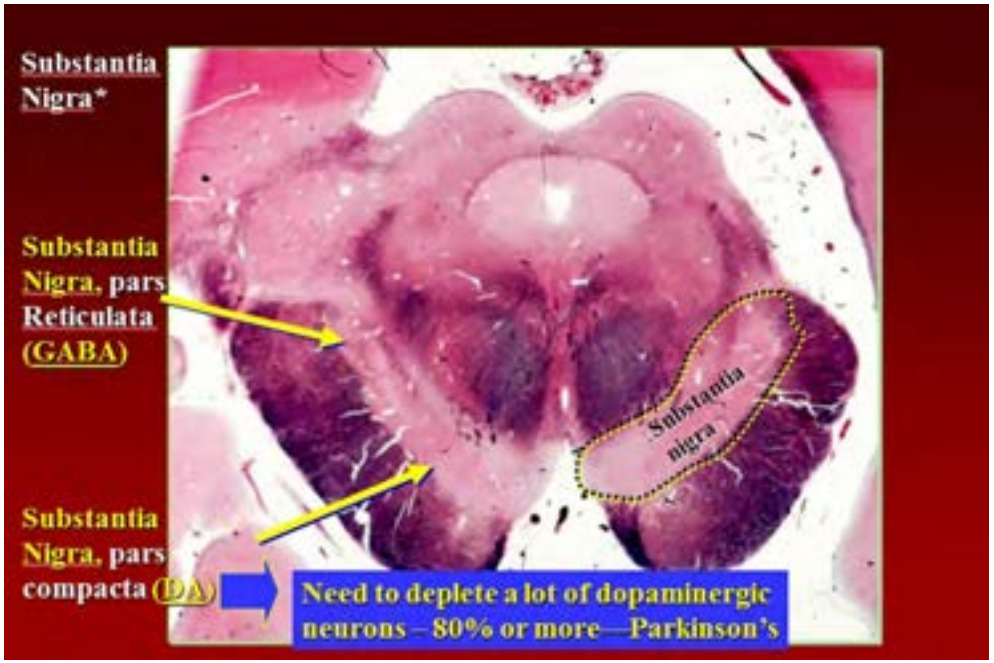
- Neurodegenerative disorder most **commonly associated with Alzheimer disease** pathology
- Characterized by complaints of progressive visual changes
  - Can have a homonymous hemianopia
- A delay in diagnosis of PCA is common
- Search for ocular causes for visual complaints; brain MRI may be interpreted as normal



https://radiopaedia.org/images/4634739

Parkinson's Disease

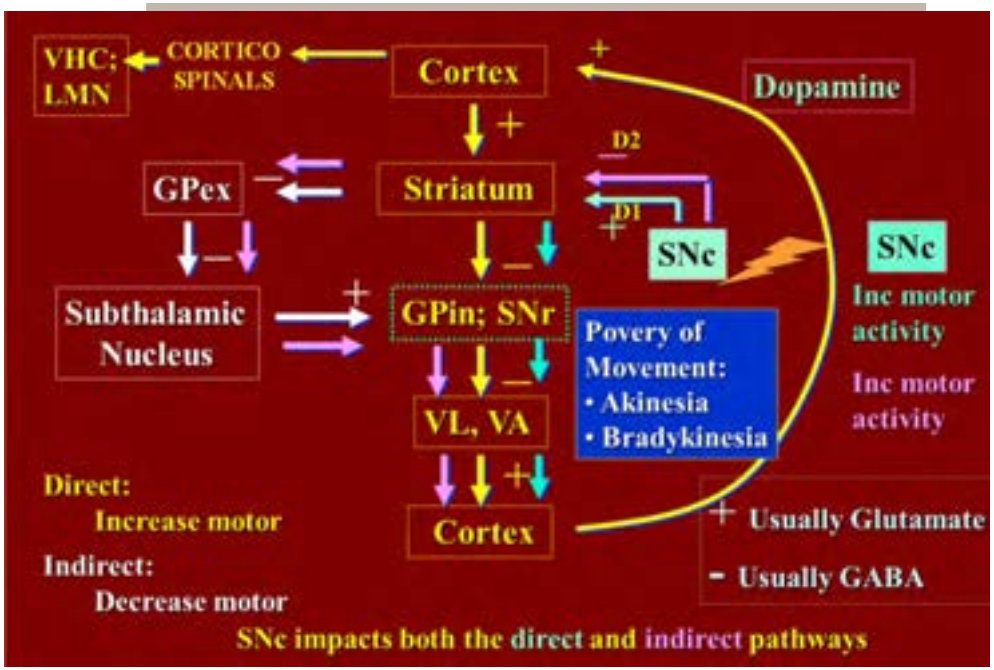
- Considered the 2nd most common neurodegenerative disorder
- The mean age of onset is 60 years
- Caucasians are more affected than African and Asian Americans
- Higher rates of occurrence in the Midwest/Great Lakes region and the northeastern USA



Parkinson's Disease

Pathophysiology

- Substantia nigra pars compacta
  - Normally facilitates an increase in motor activity
    - Facilitates the direct pathway
    - Inhibits the indirect pathway
  - Dysfunction of the substantia nigra causes a decrease in motor activity
  - When approximately 60-80% of the dopaminergic neurons are affected symptoms of Parkinson's begin



Parkinson's Disease

Manifestation

- Dyskinesia
  - Bradykinesia
  - Akinesia
  - Resting tremor
- Dystonia
- Postural Instability

- Flattened facial expression
- Hypophonia
- Micrographia
- Dream re-enactment
- Autonomic Nervous System
- Fluctuation in Attention
- Dementia

CLINICAL CHARACTERISTICS OF AD vs PD

Alzheimer Disease (AD)	*Parkinson Disease (PD)*
Progressive memory impairment	Bradykinesia (slowness of movement)
Impaired executive function (decision making and multi-tasking)	Rigidity and/or Resting Tremor
Behavioral changes (irritability and disengagement)	Postural Instability (later in disease)
Circadian rhythm sleep disturbances	Responds to dopaminergic therapy
Olfactory dysfunction	Olfactory dysfunction

WHAT IS PARKINSONISM?

- Autonomic dysfunction
- Tremors
- Slow movement (bradykinesia)
- Muscle rigidity
- Postural instability

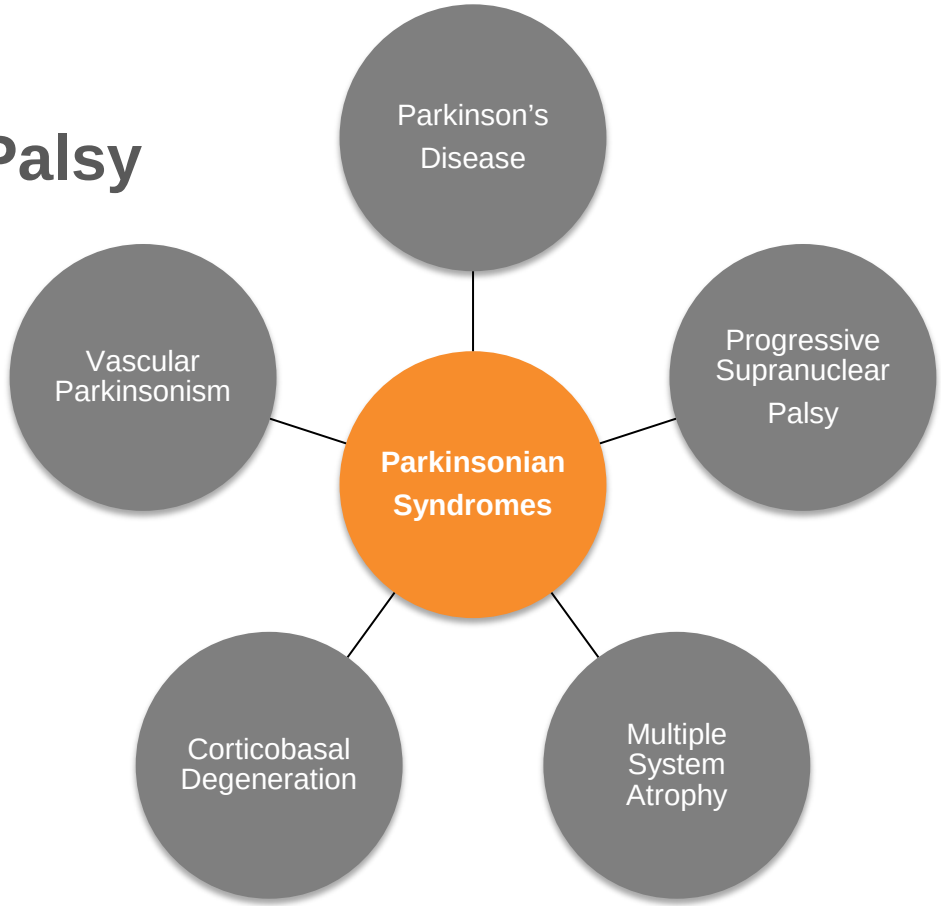
Parkinson's Disease is the most common cause of parkinsonism.

DISTINGUISHING SYSTEMIC FEATURES OF ATYPICAL PARKINSONIAN SYNDROMES

LBD (*Lewy Body Dementia*)	*MSA* (*Multiple System Atrophy*)		*PSP* (*Progressive Supranuclear Palsy*)	*CBD* (*Corticobasal Degeneration*)
Dementia with visual hallucinations early in disease Fluctuating cognition REM sleep behavior disorder	Autonomic dysfunction early - Orthostatic hypotension (falls) - Loss of bladder control Cognitive function well preserved Rapid progression (shorter life-span)		Impaired vertical gazes Postural instability: prone to backwards falls Mild executive dysfunction Facial dystonia Mircrographia	Asymmetric limb involvement early in disease Impaired cognition early Profound rigidity Dysarthria Impaired pursuits and saccades Ideomotor apraxia (inability to imitate gestures)
	MSA – P Subtype (predominant Parkinsonism)	*MSA – C Subtype* (predominant cerebellar ataxia)		
	Motor dysfunction similar to PD	Gait and limb ataxia Dysarthria Gaze-evoked nystagmus Ocular dysmetria		

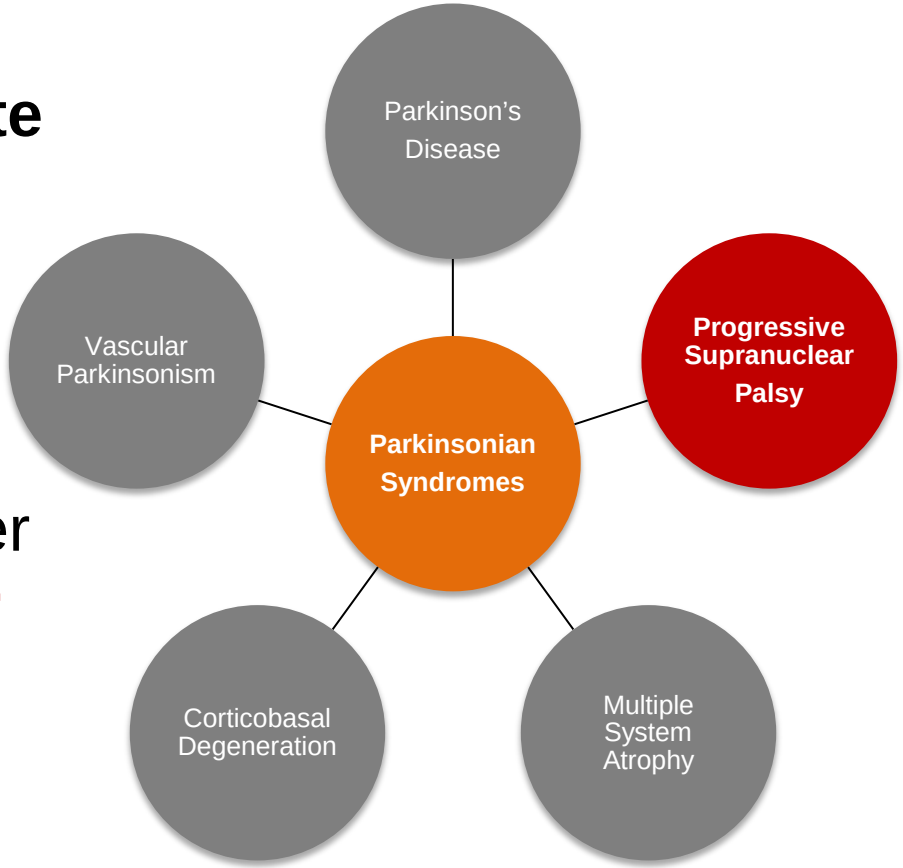
Parkinsonian Syndromes

- **Parkinson's Disease**
- **Progressive Supranuclear Palsy**
- **Multiple System Atrophy**
- **Corticobasal Degeneration**
- **Vascular Parkinsonism**



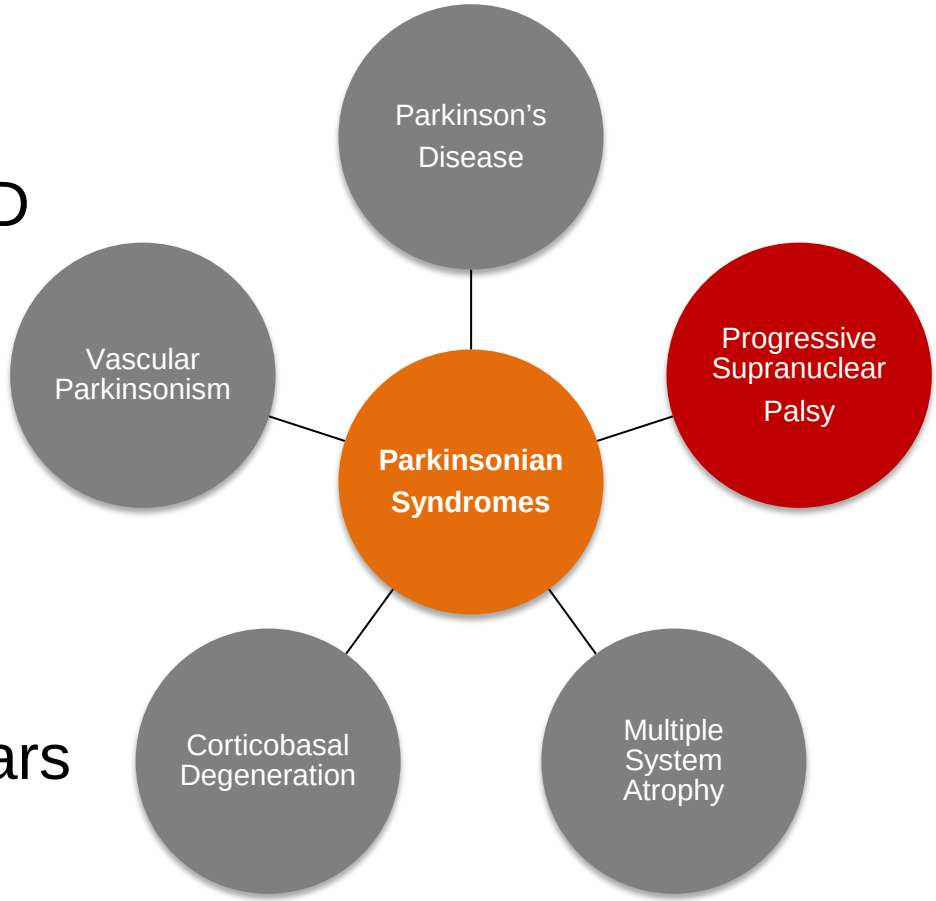
How To Differentiate From Parkinson's Disease

- **PD should not demonstrate limited vertical ductions**
- If **limited vertical eye movements** (particularly downgaze), need to consider **Progressive Supranuclear Palsy (PSP)**



Progressive Supranuclear Palsy (PSP)

- More severe and faster progression compared with PD
- Responds poorly to L-dopa
- Early falls (often backwards)
- Average time to death is 7 years



NEURODEGENERATIVE DISEASES: THE PURPOSE OF CLINICAL DIAGNOSIS

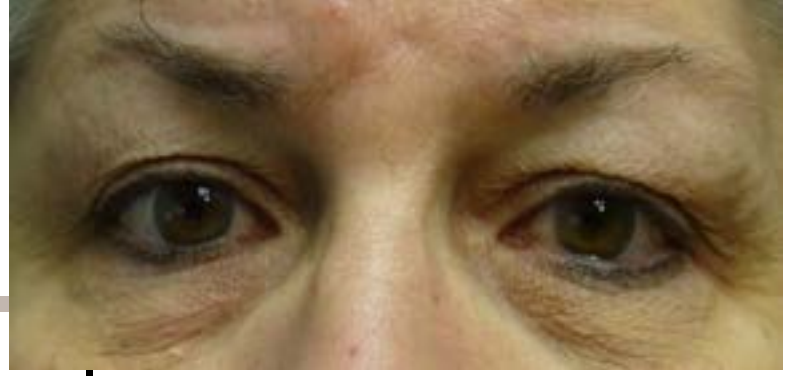
- Diagnosis is entirely clinical
  - No imaging, biochemical or genetic tests give definite dx
- Diagnosis relies on medical history
  - Timeline of symptoms
  - Important, differentiating clinical signs
  - Differentials

- Although it may not change treatment, it is important to inform the patients, caregivers, family and multidisciplinary care team about the prognosis and progression

CASE 4
Neurdegenerative Disease

66 Year-Old Woman

- Referred by neurology due to abnormal EOMs
- Has been having trouble walking, but she attributes it to arthritis of her knees
- When she gets up, she has to wait for a while before moving
- She holds onto her husband when she walks



- Currently wearing progressive lenses
- Having some difficulty with prolonged reading
- She would like to spend more time reading
- Denies diplopia

- Not currently driving; her husband is not comfortable with letting her drive until they figure out what is going on
- She wants to get back to driving

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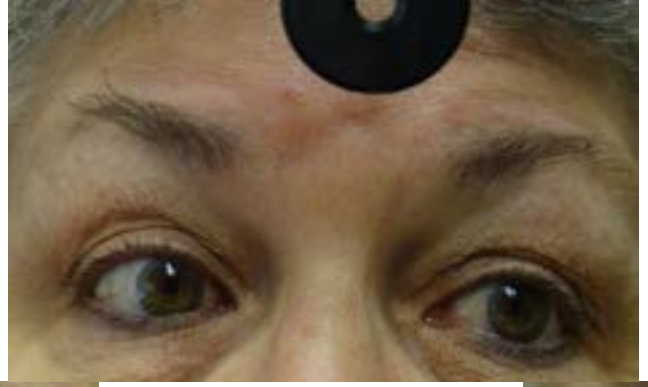

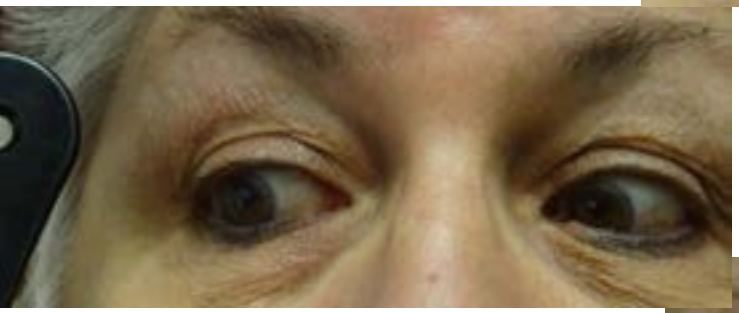

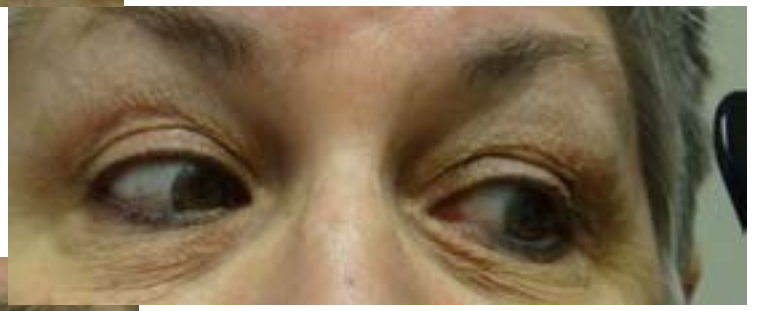

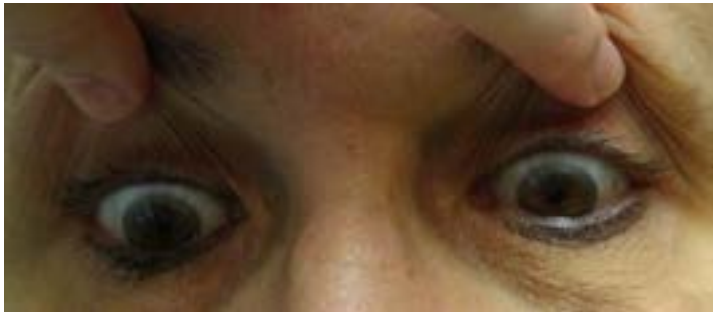

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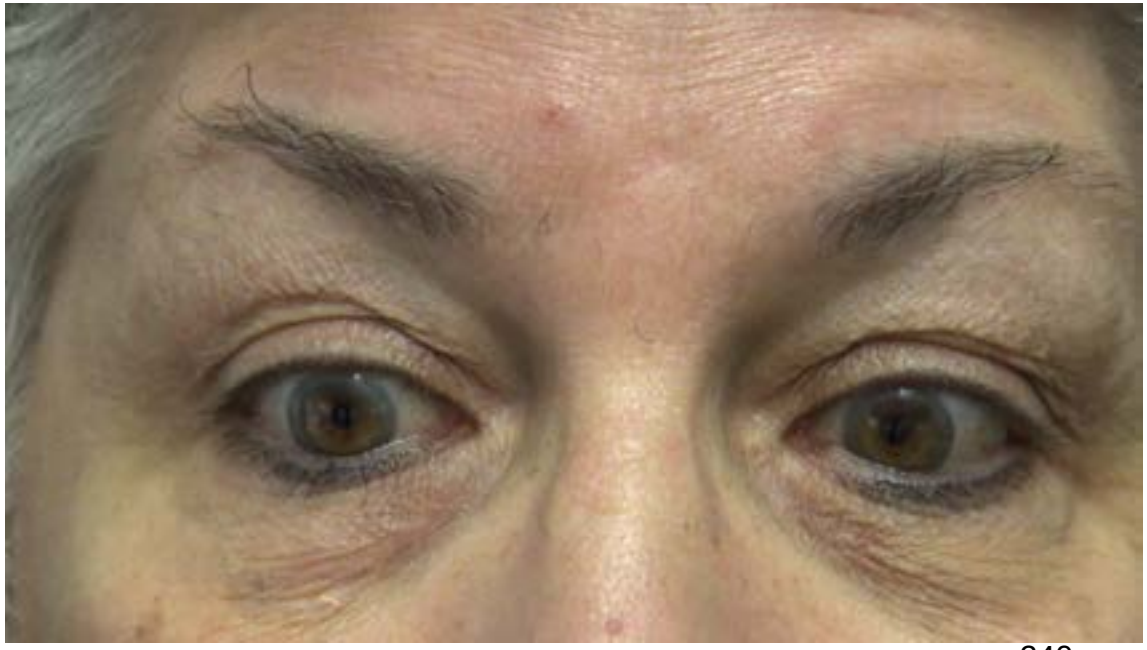

Doll's Head (Oculocephalic) Reflex

- Add video…

A dissociation between impaired voluntary eye movements (pursuits and saccades) and preserved involuntary eye movements (VOR) is called a supranuclear gaze palsy. This is most commonly seen in PSP.

The Doll's head maneuver assesses the vestibulo-ocular reflex (VOR). It can be helpful to distinguish limited ductions as either supranuclear or infranuclear in origin.

The fact that the ability to move the eyes up and down is greater with the Doll's Head maneuver than just with ductions confirms that it is a **supranuclear problem**. Therefore, we know it is not a problem with the nerves, NMJ, or muscles.

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What Can We Do To Help?

- Since her vertical motilities are limited (superior > inferior) we need to get her out of progressive lenses
  - They are constantly making her try to make vertical eye movements
- She will do better with separate DVO and NVO lenses
- Incorporated yoked prism since she cannot move her eyes up at all.
  - Want to move image down slightly so it is move comfortable for her
  - 3 BU prism OU (3 BU in each eye)

- Also, recommended a reading stand so that her reading material can be held at eye level

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PANEL DISCUSSION

Visual Symptoms Are Very Common in Neurodegenerative Diseases!

frontiers in Neurology

Visual and Ocular Manifestations of Alzheimer's Disease and Their Use as Biomarkers for Diagnosis and Progression

*Fatimah Zara Javaid[1], Jonathan Brenton[1], Li Guo[1] and Maria F. Cordeiro[1,2]**

Visual symptoms are very common in AD!

TABLE 2 | Visual manifestations of AD.

Indicator of vision	Manifestation of AD	Recommended clinical test[a]
Visual acuity	Decreased visual acuity in low luminance (32, 33)	HOTV chart
Contrast sensitivity	Reduced visual contrast sensitivity particularly in low frequencies (37, 38) Reduced reading speed at lower contrast sensitivities (37)	Pelli–Robson chart (35) Michelson contrast test (37)
Color vision	Poor color discrimination (43) Deficiencies most significant in tritan axis (31, 42)	City University test Ishihara test (154)
Visual field loss	Inferior hemifield loss (45)	Humphrey automated perimetry (45) FDT (46)
Motion perception	Higher thresholds for motion detection across all spatial frequencies (57)	Computer animation sequences using random dot cinematogram (57)
Depth perception and stereopsis	Reduced stereopsis, mean threshold >150 s of arc	Randot stereotest (155)
Ocular motor function	Abnormal hypometric saccades Increased latency as compared to controls (50, 51)	Eye movement examination (62)

[a]All clinical tests require patient cooperation, which can be difficult in AD patients.
AD, Alzheimer's disease; FDT, frequency doubling technique.

SAGE-Hindawi Access to Research
Parkinson's Disease
Volume 2011, Article ID 908306, 9 pages
doi:10.4061/2011/908306

Research Article

Visual Symptoms in Parkinson's Disease

R. A. Armstrong

Visual symptoms are very common in PD!

- **Approximately 80% of patients report at least 1 visual symptom.**
- The earlier symptoms are addressed and treated, the better quality of life of the PD patient

Table 1: Visual signs and symptoms of Parkinson's disease (PD).

Ocular aspect	Change in PD
Visual acuity	Poor, especially at low contrast
Colour vision	Vision blurred for coloured stimuli Shortened colour fusion time Progressive deterioration
Visual fields	Increase in glaucomatous visual field defects Side effects of surgery
Saccadic eye movement	Reaction time and max. velocity of horizontal gaze slower Hypometria Amplitude increased after cued saccades Affected early in disease process
Smooth pursuit movement	Superimposed saccades Reduction in response magnitude
Optokinetic Nystagmus	Abnormal in some patients
Convergence	Impaired, associated with large exophoria, diplopia
Blink frequency	Reduced, causing abnormal tear film, dry eye and reduced vision
Blink reflex	Habituation not observed
Pupil diameter	Larger after light adaptation with anisocoria
Light reflex	Longer latency
Constriction time	Increased
Contraction amplitude	Reduced
Contrast sensitivity (CS)	Abnormal in some cases, intermediate to high frequencies
Temporal processing	Impaired ability to track rapid fluctuations Duration perception affected
Flash ERG	Reduced amplitude of "b" wave Reduced amplitudes.
PERG	Specific defect at medium SF Delayed P50
Cortical VEP	Delayed P100
Chromatic VEP	Increased latency and reduced Amplitude (esp. blue-yellow)
ERP	Abnormal. Delayed reaction times
Visuo-spatial	Difficulty in judging verticals, position of body parts, and in route-walking tasks
Orientation and motion discrimination	Impaired
Facial perception	Impaired ability to perceive and imagine emotional faces
Visual hallucinations	Chronic in 30–60% of treated cases

Abbreviations: ERG: Electroretinogram, ERP: event-related potentials, PERG: Pattern electroretinogram, SF: Spatial frequency, VEP: Visual evoke

AD &PD and Afferent Function Symptoms are Similar

- Blur
- Difficulty seeing in twilight or in rain
- Colors are washed out
- Vision just is not right

- Reduced Visual Acuity
- Reduced Color Discrimination
- Reduced Contrast Sensitivity

PD and Eye Movements

Basal ganglia are involved in saccadic eye movements

- **Abnormal saccadic and smooth pursuit eye movements in about 75% of PD patients!**

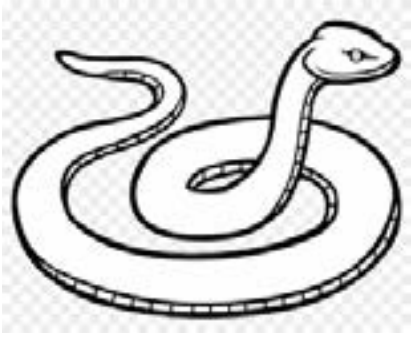
- **SACCADES**
  - **Reduced maximum velocity and reaction time**
  - **Hypometric (early stages)**
  - **Increased latency (later stages)**

- **PURSUITS**
  - **Saccadic pursuits**
  - **Jerkiness and "cog-wheeling" of eye movements**
    - Vertical movements more impaired
  - **Progressive decline of pursuit response with repetition**

PD Associated Dry Eye Syndrome

- VERY COMMON
  - **Ocular surface irritation**
  - **Affects up to 60% of PD patients**
  - Due to:
    - Poor tear distribution
    - Poor tear production
    - Abnormal tear composition
    - **Decreased blink rate and amplitude (akinesia / bradykinesia)**
      - Increased blink duration
      - No habituation of blink reflex with tap above bridge of nose
        - Glabellar reflex (primitive reflex)

There can be a classic "serpentine stare" appearance in PD due to reduced blink rate



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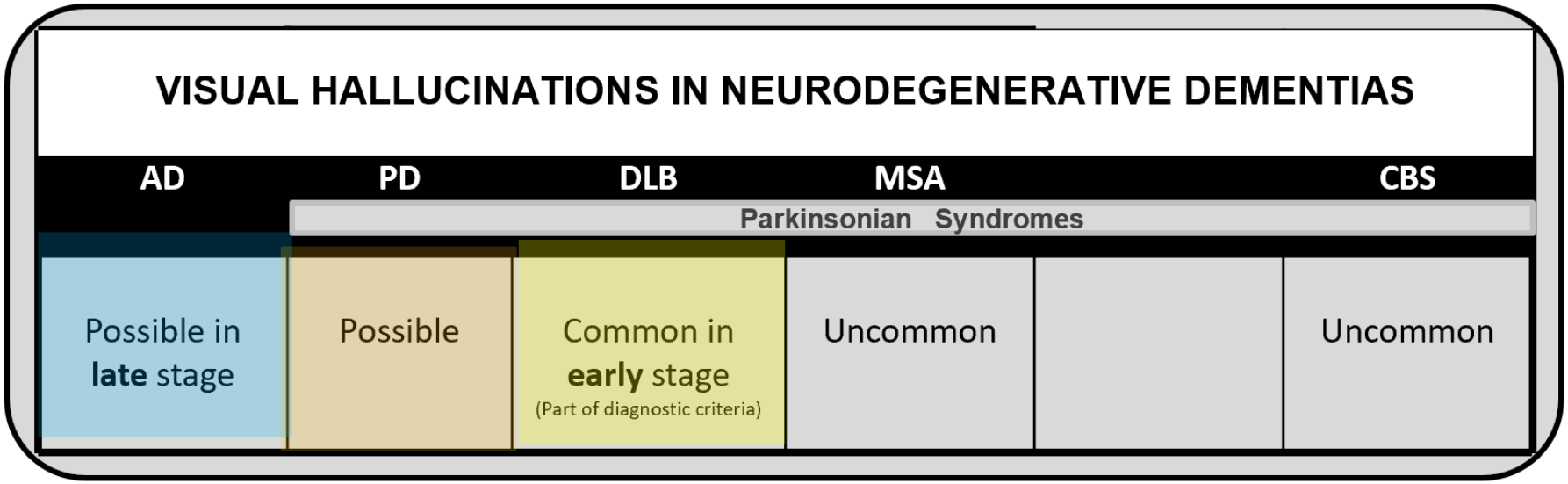
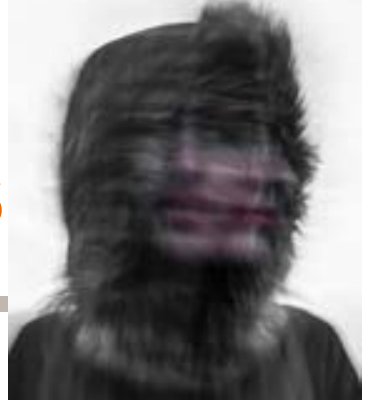
Visual Hallucinations in Neurodegenerative Disease

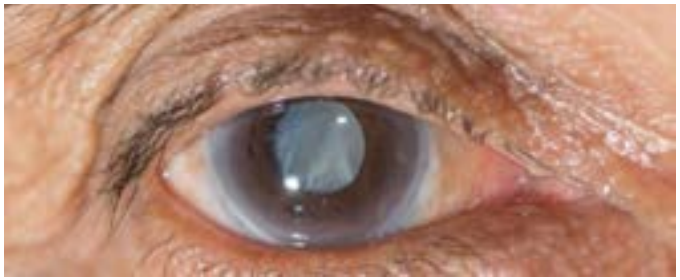


AD and Hallucinations



Visual hallucinations are a common finding

- Associated with more rapid cognitive decline
- **60% of patients with visual hallucinations, could improve with refraction**
- **Cataracts significantly associated with visual hallucinations**
- **Hallucinations were not seen with normal visual acuity**



AD PATIENTS BENEFIT FROM CATARACT SURGERY!

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PD and Hallucinations

- Occurs more often in the setting of
  - Insomnia (REM sleep disorders)
  - Daytime sleepiness
  - Moderate to severe cognitive issues
  - Longer duration of PD
  - Reduced visual acuity
  - **PD medications (all cause hallucinations,** but these more so)
    - Amantadine
    - Mirapex
    - Neupro
    - Requip

Visual hallucinations are common in PD!

About 50% of PD patients experience hallucinations!

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VISUAL HALLUCINATIONS

Hallucinations

- Simple (non-formed)
- Complex (formed)
  - Formed
    - People
    - Animals
    - Objects
    - Vivid scenes
    - Colors

Parkinsonian hallucinations are usually <u>complex</u>, binocular hallucinations which occur throughout the entire VF

PD and Hallucinations

- TREATMENT
  - Reassurance
  - Change in meds

If severe, there is now a medication to treat PD hallucinations – Pimavanserin (Nuplazid)

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DEMENTIA WITH LEWY BODIES

- **Visual hallucinations**
  - Occur in **2/3 of patients with DLB**
  - **Early sign in DLB and may precede parkinsonism**
  - Often under-reported unless specifically asked about
  - Patient reactions to the hallucinations
    - Fear
    - Indifference
    - Enjoyment

Visual hallucinations are a useful feature to distinguish DLB from AD. Hallucinations occur more often in DLB as compared with AD.

- Descriptions range:
  - well-formed images of people or animals
  - abstract visions such as shapes or colors
  - visual misperceptions
    - object seems to move, zoom toward or away from the patient, or change shape.

Remember, in AD, hallucinations were NOT seen with normal VA.

Criteria for Diagnosing Dementia with Lewy Bodies.

Core clinical features:

- **Fluctuating cognition**
- **Visual hallucinations**
- **REM sleep behavior disorder**
- **Parkinsonian features**

Revised criteria for the clinical diagnosis of dementia with Lewy bodies (DLB)

Probable DLB	• Two or more core clinical features of DLB are present, with or without indicative biomarkers; **OR** • Only one core clinical feature is present, but with one or more indicative biomarkers • Probable DLB should not be diagnosed on the basis of biomarkers alone
Possible DLB	• Only one core clinical feature of DLB is present, with no indicative biomarker evidence; **OR** • One or more indicative biomarkers are present, but there are no core clinical features
DLB is **less likely**	• In the presence of any other physical illness or brain disorder including cerebrovascular disease, sufficient to account in part or in total for the clinical picture* • If parkinsonian features are the only core clinical feature and appear for the first time at a stage of severe dementia¶
Essential features	**Dementia**Δ
Core clinical features (the first three typically occur early and may persist throughout the course)	• Fluctuating cognition with pronounced variations in attention and alertness • Recurrent visual hallucinations that are typically well formed and detailed • REM sleep behavior disorder, which may precede cognitive decline • One or more spontaneous cardinal features of parkinsonism (bradykinesia, rest tremor, rigidity)
Supportive clinical features	• Severe sensitivity to antipsychotic agents • Postural instability • Repeated falls • Syncope or other transient episodes of unresponsiveness • Severe autonomic dysfunction (eg, constipation, orthostatic hypotension, urinary incontinence) • Hypersomnia • Hyposmia • Hallucinations in other modalities • Systematized delusions • Apathy, anxiety, and depression
Indicative biomarkers	• Reduced dopamine transporter uptake in basal ganglia by SPECT or PET • Abnormal (low-uptake) ^{123}Iodine-MIBG myocardial scintigraphy • Polysomnographic confirmation of REM sleep without atonia
Supportive biomarkers	• Relative preservation of medial temporal lobe structures on CT/MRI scan • Generalized low uptake on SPECT/PET perfusion/metabolism scan with reduced occipital activity a cingulate island sign on FDG-PET imaging • Prominent posterior slow-wave activity on EEG with periodic fluctuations in the pre-alpha/theta range

DLB: dementia with Lewy bodies; REM: rapid eye movement; SPECT: single-photon emission computed tomography; PET: positron emission tomography; MIBG: metaiodobenzylguanidine; CT: computed tomography; MRI: magnetic resonance imaging; FDG: fluorodeoxyglucose; EEG: electroencephalography.

* These do not exclude a DLB diagnosis and may serve to indicate mixed or multiple pathologies contributing to the clinical presentation.

¶ DLB should be diagnosed when dementia occurs before or concurrently with parkinsonism. The term "Parkinson disease dementia" (PDD) should be used to describe dementia that occurs in the context of well-established Parkinson disease.

Δ Dementia is defined as a progressive cognitive decline of sufficient magnitude to interfere with normal social or occupational functions, or with usual daily activities. Prominent or persistent memory impairment may not necessarily occur early in the early stages but is usually evident with progression. Deficits on tests of attention, executive function, and visuoperceptual ability may be especially prominent and occur early.

Modified from: McKeith IG, Boeve BF, Dickson DW, et al. Diagnosis and management of dementia with Lewy bodies: Fourth consensus report of the DLB Consortium. Neurology 2017; 89:88. DOI: 10.1212/WNL.0000000000004058. Copyright © 2017 American Academy of Neurology. Reproduced with permission from Lippincott Williams & Wilkins. Unauthorized reproduction of this material is prohibited.

Visual hallucinations are under-reported by patients who fear that the hallucinations represent psychiatric disease or who lack insight into the unreal nature of the hallucinations.

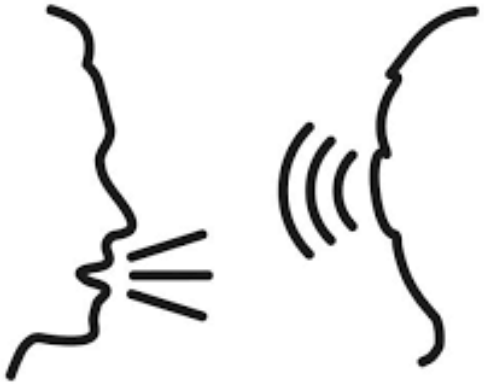
We need to ask patients if they are experiencing visual hallucinations.

Kathy Discussion regarding NDG rehab (some suggestions)

- CI in Parkinson's – BI prism
- Separate DVO and NVO Rx vs PALs
- Use of yoked prism in PSP

Cognitive Impairments & Dementias

- Since most parts of the brain play some role in visual function, these conditions will have some visual / ocular manifestations.
  - STRUCTURAL
    - OCT
    - OCT-A
    - OCULAR HEALTH
  - FUNCTIONAL
    - AFFERENT
    - EFFERENT



Listening to the patient and their caretaker will help you know how you can best help them.

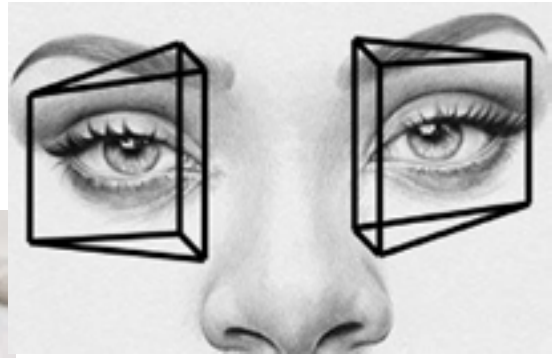
COGNITIVE IMPAIRMENT & DEMENTIA

- Patients will often have problems with:
  - Reading
  - Driving
  - Performing tasks that depend on visual cognition
  - Diplopia
  - Eye movement abnormalities

- Our job is to assess and manage visual cognition and to improve visual function when possible

PD and Binocular Diplopia from CI

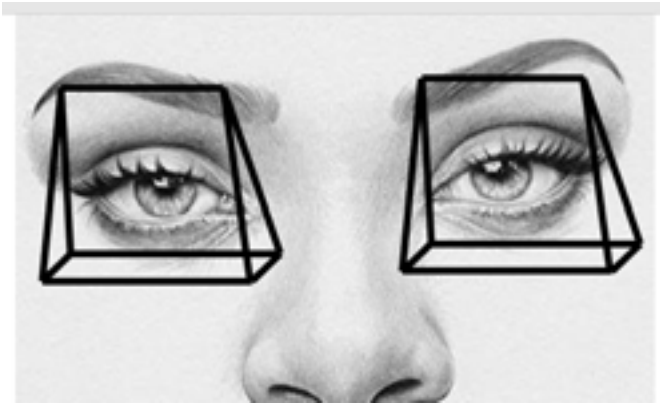
- Separate glasses for distance and near
- BI prisms in reading glasses
- Vision Therapy
- Patching



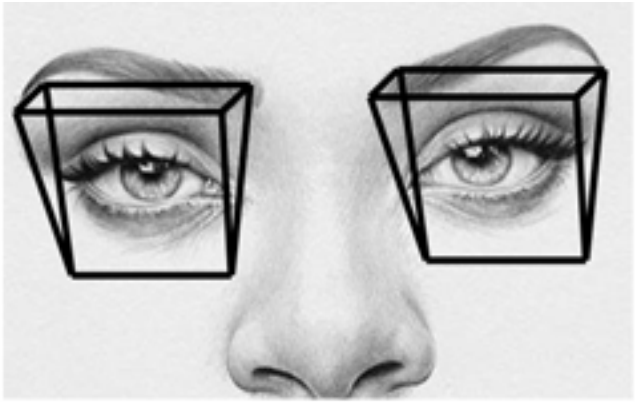
- **Recommend reading stand due to hand tremors**

Yoked Prism in PSP

- Reduced Vergence Ranges



Helps with Reduced Infraduction



Helps with Reduced Supraduction

Traditional Neuroimaging is Not Diagnostic in Neurodegenerative Disease

- Imaging is done to rule out other etiologies for the clinical presentation

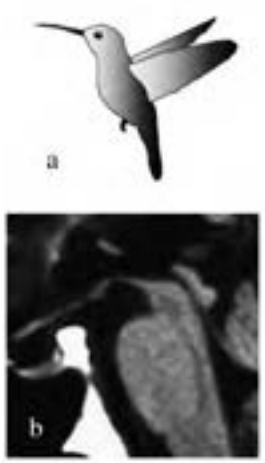
- There are no reliable imaging biomarkers for AD
- DaT scan may be helpful in PD
- Midbrain atrophy may be seen in PSP

PSP - diagnosis

Characteristic eye movements help confirm the diagnosis of PSP

- **Initially as slowing of vertical saccades**
- **Gradually evolve into hypometric saccades, square-wave jerks (fixation instability)**
- **Eventually supranuclear vertical gaze palsy**

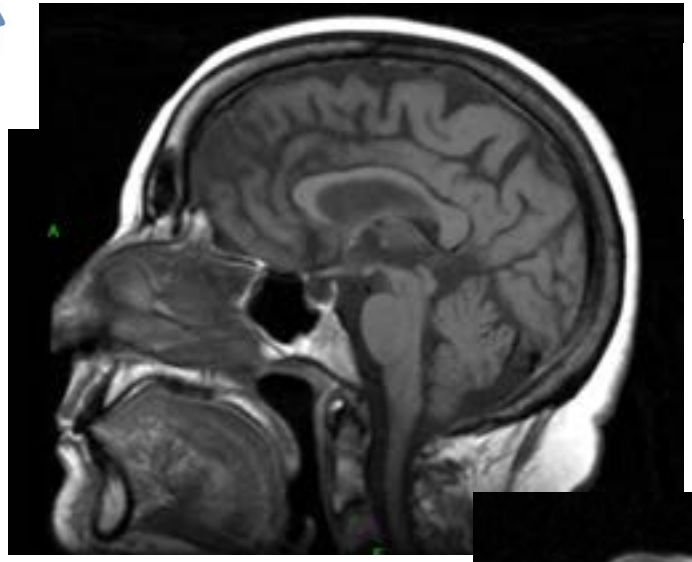
The radiologic **hummingbird sign** (also called the penguin silhouette sign) results from the prominent midbrain atrophy in PSP with a relatively preserved pons, resembling a hummingbird or penguin in silhouette on midsagittal MRI of the brain.

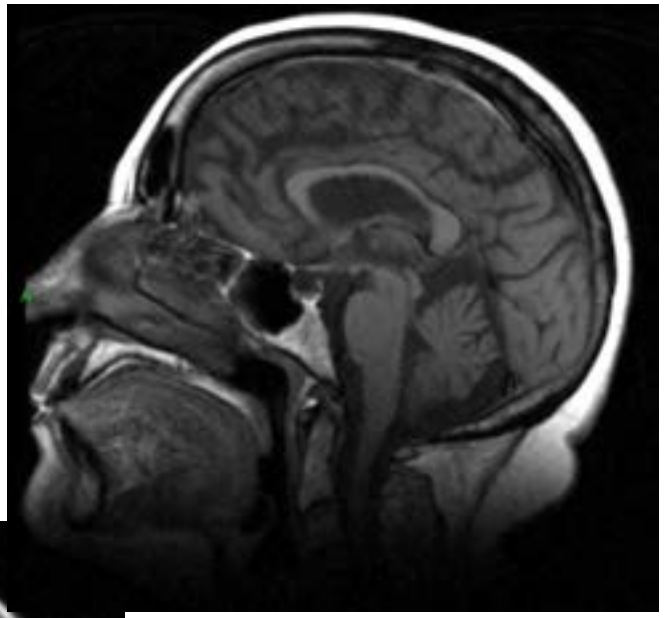


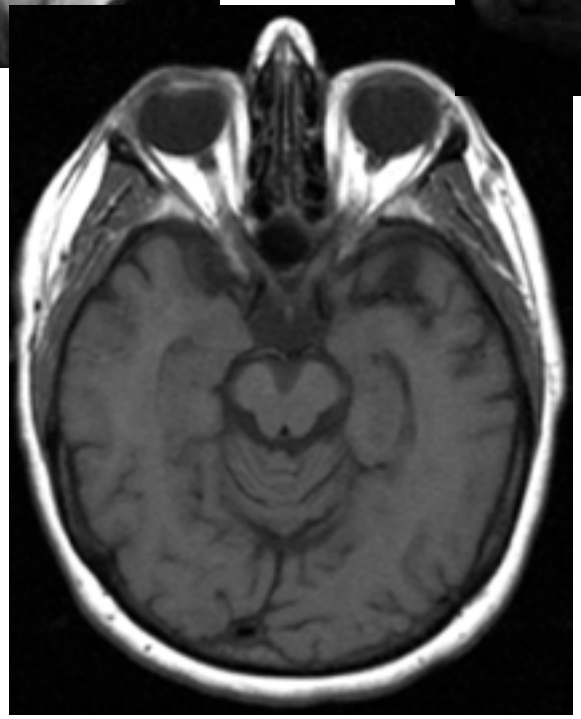
Remember that the midbrain is the vertical gaze center.

Classic Hummingbird sign of MRI

Neuropathologic examination remains the gold standard for its definitive diagnosis







OCT in Neurodegenerative Disease

The pathological changes of Alzheimer's Disease (AD) occur decades before the onset of dementia, but AD is typically diagnosed late in the disease course when extensive and irreversible neurodegeneration and vascular damages have already occurred.

There is great interest in discovering new **biomarkers that can identify individuals suffered from earlier stages of AD**, which are more likely to benefit from any effective treatments.

We will have a role in assessing risk of AD and other forms of dementia by use of OCT.

The retina is an extension of the brain embryologically, anatomically and physiologically. It is the CNS.

OCT is Alzheimer's has been studied a bit more tan OCT in Parkinson's. But, similar concepts apply.

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Spectral Domain-Optical Coherence Tomography Measurements in Alzheimer's Disease: A Systematic Review and Meta-analysis

Victor T.T. Chan[1,2], **Zihan Sun**[1], **Shumin Tang**[1], **Li Jia Chen**[1], **Adrian Wong**[2], **Clement C. Tham**[1], **Tien Y. Wong**[3,4], **Christopher Chen**[5,6], **M. Kamran Ikram**[7], **Heather E. Whitson**[8,9], **Eleonora M. Lad**[8], **Vincent Mok**[*,2,10], and **Carol Y. Cheung**[*,1]

Conclusion: Our results confirmed the associations between retinal measurements of SD-OCT, and AD, highlighting the potential utility of SD-OCT measurements as biomarkers of AD.

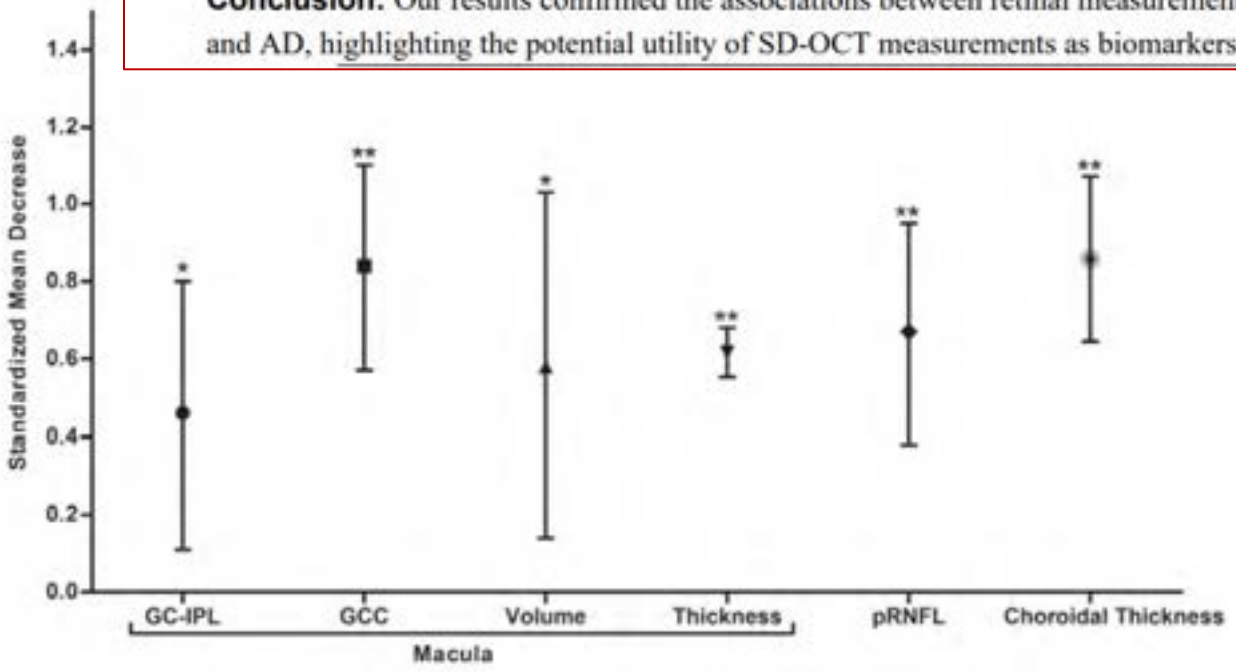

Figure 13: Differences in SD-OCT measurements between subjects with AD and controls
The standardized mean decreases of SD-OCT measurements in AD are shown. The bars represent the 95% confidence intervals of the standardized mean decreases. Significant group differences with $p < 0.05$ and $p < 0.001$ are labelled as "*" and "**" respectively.

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2 Possible Mechanisms For SD-OCT Findings in AD

- The cerebral pathology of AD may affect the visual pathway and cause **retrograde degeneration** of the optic nerve
  - AD pathologic features can be found in subcortical visual centers
    - lateral geniculate nucleus
    - superior colliculus
  - **RGC neuronal abnormalities were also associated with non-AD dementias**

- Alternatively, it is also possible that **AD pathology occurs simultaneously both in the brain and the retina**, leading to thinning of the retinal neuronal layers.

frontiers in Neurology

Optical Coherence Tomography in Alzheimer's Disease and Other Neurodegenerative Diseases

Jonah Doustar[1], Tania Torbati[1,2], Keith L. Black[1], Yosef Koronyo[1] and Maya Koronyo-Hamaoui[1,2]*

The apparent correlations between OCT-structural findings and visual and cognitive functions in AD patients support its utilization in assessing neurodegenerative incidence and progression.

However, while the geometric distribution of progressive tissue atrophy is profound in the superior and inferior quadrants of AD retina, the potential **overlap of the structural changes between various neurodegenerative diseases**, such as PD, HD, and MS may instill **an inherent limitation in differential diagnosis** that should be addressed in future studies

OCT is likely a biomarker for neurodegenerative diseases.

TABLE 2 | Correlations between OCT findings and clinical dysfunction/progression in AD and PD patients.

Clinical diagnosis	Region	OCT type	Degree of correlation[a]	Reference
Correlations				
Alzheimer's disease/mild cognitive impairment				
RNFL thickness vs. cognitive function[b]	All quadrants	sd-OCT, fd-OCT	$r = 0.33$	(43)*, (74, 76)**
	Superior	fd-OCT	$r = 0.24$	(74)*
	Inferior	sd-OCT, fd-OCT	$r = 0.35$–0.65	(50)*, (74)**
	Temporal	NA	NA	NA
	Nasal			
GCL-IPL thickness vs. cognitive function[b]	All quadrants	fd-OCT	$r = 0.33$–0.49	(37, 74)*
Macular thickness vs. cognitive function[b]	All quadrants	sd-OCT, fd-OCT	$r = 0.34$	(74)*, (76)**, (38, 41, 75, 82)**
	Superior	fd-OCT	$r = 0.47$	(74)**
	Inferior		$r = 0.46$	
	Temporal		$r = 0.49$	
	Nasal		$r = 0.48$	
RNFL thickness vs. visual function	All quadrants	sd-OCT	$r = 0.46$–0.76	(67, 70, 93, 94)*, (79)**
Parkinson's disease				
RNFL thickness vs. disease progression	All quadrants	sd-OCT, stratus-OCT	$r = 0.39$–0.66	(85, 86)*
RNFL thickness vs. visual function		sd-OCT	$r = 0.40$	(86)**, (87)***

[a]Pearson (r) correlations are represented as absolute values.
[b]Cognitive function examinations: ADAS-cog, CDR, and MMSE.
*$p < 0.05$.
**$p < 0.001$.
***$p < 0.0001$.
nd, statistical data not shown; ns, a trend, not statistically significant; NA, not applicable; sd-OCT, spectral domain-OCT; fd-OCT, frequency domain-OCT; ADAS-cog, AD Assessment Scale-cognition; CDR, Clinical Dementia Rating; MMSE, Mini-Mental State Examination.

Be sure to keep up with the future literature regarding OCT and other ocular biomarkers in neurodegenerative disease and other brain insult.

We are a piece of the puzzle, and will have an evolving role in brain insult as more ocular biomarkers are studied.

YOU WILL SEE PATIENTS WITH BRAIN INSULT

Various presentations

Various etiologies

Various symptoms

Every patient will need a unique management plan

Every patient will need your help (even if it is just reassurance that their visual function / ocular health is good or will improve)

Every patient will be counting on your opinion and guidance

Every patient will be grateful for any help, recommendations, or referrals you can provide!

YOU are a piece of the brain insult puzzle!

Regardless of how small your piece is, it is still vital to your patient's prognosis and / or quality of life.

Don't underestimate your role in diagnosis, management and rehabilitation of brain insult

THANK YOU!