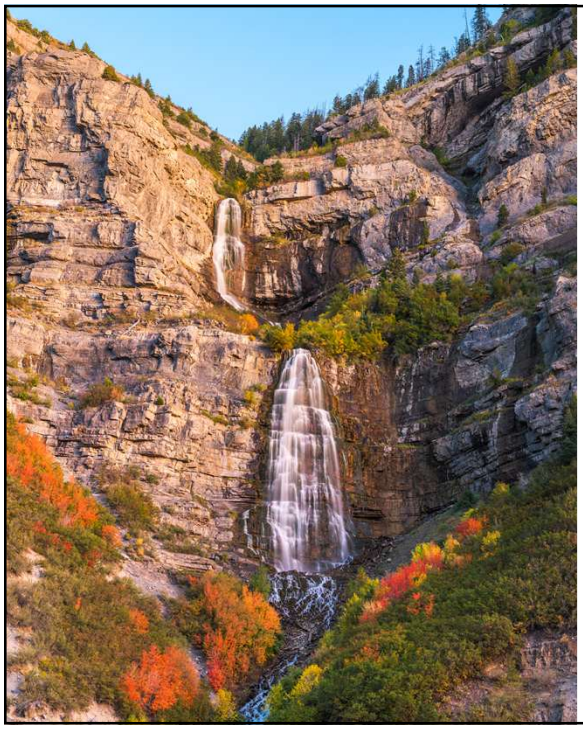

From Shadows to Solutions: Radiographic Principles & Clinical Cases

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Eyecon 2026

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Disclosures

- No financial disclosures
- Associate Professor, RMUoHP

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Learning Objectives

1. Describe and interpret specialized in-office neuro-ophthalmic assessments.
2. Differentiate between primary imaging modalities that are pertinent in eyecare.
3. Understand and describe MRI sequences and ordering parameters.
4. Formulate a systematic diagnostic approach for diagnoses of exclusion.

3

47 HM
"Droopy eyelid and double vision"

4

“Droopy eyelid and double vision”

- Sudden onset of left frontal headache (8/10) seven days ago
  - Minimal change with Excedrin po
  - Difficulties sleeping due to HA
  - Associated with:
    - Persistent pain and pressure-like sensation
    - Onset of photophobia and dizziness has since improved
- Three days after HA onset, constant RUL ptosis and horizontal diplopia when RUL lifte
- Six months prior:
  - Left sided facial numbness with persistent HA
  - Got imaging and was told WNL
  - Denies eyelid ptosis at this time
  - Associated with left sided frontal headache that seems to wax/wane until recent onset of severe HA

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Review of Systems

- Migraine
- Sinus conditions – thought to contribute to HA
- Acid reflux
- Bulging disc from MVA June 2025
- Sleep apnea
- Denied URI, TB, STI

6

Case History

- Medications:
  - Verapamil
  - Vitamin B complex
  - Phentermine
  - Doxycycline
  - Pantoprazole
- ALL:
  - NKDA
  - Environmental allergies
- SH:
  - Rare alcohol use
  - Traveled to California and Washington in last year
  - Denied travel outside US

7

Clinical Examination

- Entering VA (sc): OD 20/20, OS 20/20
- CF: OD FTFC, OS FTFC
- EOMs: see next slide
- Pupils:

PUPILS	Shape	Size in L	Size in D	Direct	Consensual	Accommodation	APD
OD	R	3 mm	4 mm	4+	4+	(+)	(-)
OS	R	3 mm	4 mm	4+	4+	(+)	(-)

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EOMs

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Ocular Health

- GAT:
  - OD 22 mmHg
  - OS 19 mmHg
- SLE: Complete RUL ptosis
- DFE: See photos

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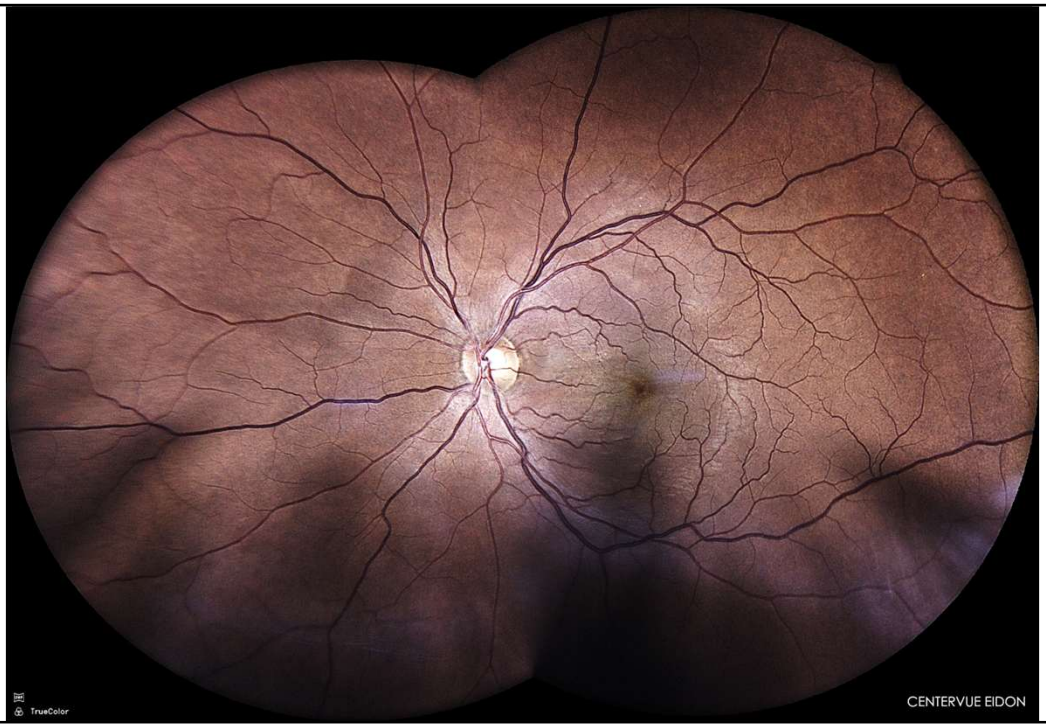

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What's Next?

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The Power of the OD

Clinical Elements of the Neuro-ophthalmic Examination

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The Essentials to the Diagnosis

- Role of the primary care eye provider → rule out an OCULAR problem
- Logical flow of traditional ocular examination
- Useful for neuro-ophthalmic problems:
  - BCVA, perimetry, pupils, color vision
  - *Extraocular motility*
  - *Parks 3-Step (or 5-Step)*
  - *Comitancy testing*
  - *Assessment of cranial nerves*

Patient Demographics & Case Hx

Age, Race, Geography
Obtain a Thorough Case History

Preliminary Testing

Entering VA (+/- PH), EOMs, CVF, Pupils, +/- CV, +/- CT / Maddox Rod

Best Corrected Visual Acuities

Function of CN 2

Ocular Health Examination

Rule out intraocular diseases, particularly of the optic nerve

Ophthalmic Ancillary Testing

Perform any testing that may beneficial such as perimetry, OCT, ERG/VEP, etc.

Medical Ancillary Testing

Order medical testing (serology, imaging) based on necessity.

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Extraocular Muscles

- Each muscle is independently innervated by one cranial nerve
- Each extraocular muscle have primary and secondary actions while some additionally has tertiary action
- Important to understand the anatomy and actions when encountering muscle dysfunction

Muscle	Primary	Secondary	Tertiary
MR	Adduction		
LR	Abduction		
IR	Depression	Excyclotorsion	Adduction
SR	Elevation	Incyclotorsion	Adduction
IO	Excyclotorsion	Elevation	Abduction
SO	Incyclotorsion	Depression	Abduction

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EOM Limitations

- Is this a mechanical problem or an innervation problem?
- Terminology to understand:
  - ***Restriction*** due to mechanical limitation such as physical block
  - Innervation due to dysfunction of neural input:
    - ***Paresis***: Weakness of EOM due to impaired innervation
    - ***Palsy***: Complete lack of EOM contraction due to severely impaired innervation

Allen RC. Oculoplastics basic exam: Forced duction testing. YouTube. Published April 10, 2022. Accessed April 30, 2026. https://www.youtube.com/watch?v=CPH0pqkv25g

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Parks 3-Step (or 5-Step)

- In-office test to assess for dysfunction of the superior obliques
- Based on primary, secondary, and tertiary muscle actions of extraocular muscles

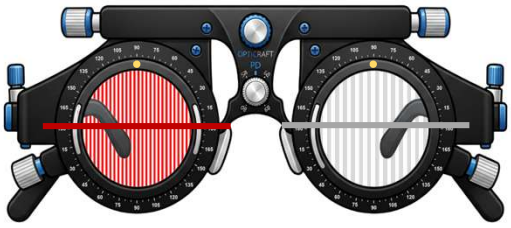
Steps	Actions & Interpretatino
Which eye is HYPER?	Identify the weak elevator and depressor muscles that are contributing to the hyper deviation.
Is deviation greater in RIGHT or LEFT GAZE?	Identify the weak abductor or adductor muscles that are contributing to the greater deviation.
Is deviation greater in RIGHT or LEFT HEAD TILT?	Identify the weak tortional muscles that are contributing to the greater deviation.
Is there EXCYCLOTORISION of the dysfunctional SO?	Confirmation of superior oblique dysfunction is noted by the presence of excyclotorsion.
Is the deviation the same in UPRIGHT vs. SUPINE position?	Decrease in magnitude of deviation when supine is more indicative of skew deviation from inner ear pathology.

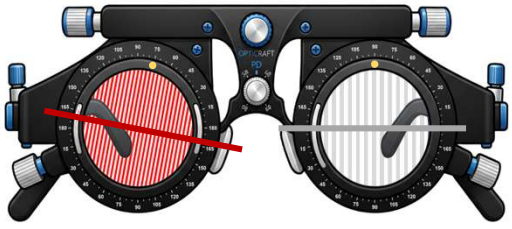
Lee AG. *The 5 steps of the 3-step test (Parks-Bielschowsky test)* [video]. YouTube. Published 2021. Accessed October 12, 2026. https://www.youtube.com/watch?v=bJ5nO_47PKc

17

Parks 4th Step: Assessing Cyclotorsion

- Qualitative and quantitative assessment of cyclotorsion
- Double Maddox Rod using trial frame and different MR colors





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Comitancy Testing

- Purpose is to assess the function of the extraocular muscles
- Useful in identifying underlying cause (e.g. neurological innervation, mechanical restriction, misalignment)
- Determine magnitude of tropia in at least 5 gazes (or all 9 gaze).
- Neutralize with prism objectively (cover test) or subjectively (Maddox rod)
- Considered ***non-comitant*** when:
  - More than 5 prism diopters from primary gaze to any of the other 4 gazes
    or
  - More than 10 prism diopters between extreme gazes in vertical or horizontal directions

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Clinical Assessment of Cranial Nerves

- In-office assessment of the function of the 12 cranial nerves
- Identification of more than one CN involvement
- Commonly CN dysfunction encountered in eyecare:
  - Optic
  - Oculomotor
  - Trochlear
  - Trigeminal
  - Abducens
  - Facial

Cranial Nerves	In-Office Assessments
1 Olfactory	Smell test of each nostril with eyes closed
2 Optic	BCVA, VF, fundus, color vision
3 Oculomotor	EOM testing, comitancy testing
4 Trochlear	EOM testing, Parks 3-Step
5 Trigeminal	Cotton-wisp test, mastication
6 Abducens	EOM testing
7 Facial	"Smile" test, forced eye closure, taste, facial expression/movement
8 Vestibulocochlear	Hearing test, assess balance by walking
9 Glossopharyngeal	Swallowing, gag reflex
10 Vagus	Swallow, voice quality
11 Accessory	Shoulder shrug, neck rotation
12 Hypoglossal	Tongue movement, assess for deviation

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47 HM
"Droopy eyelid and double vision"

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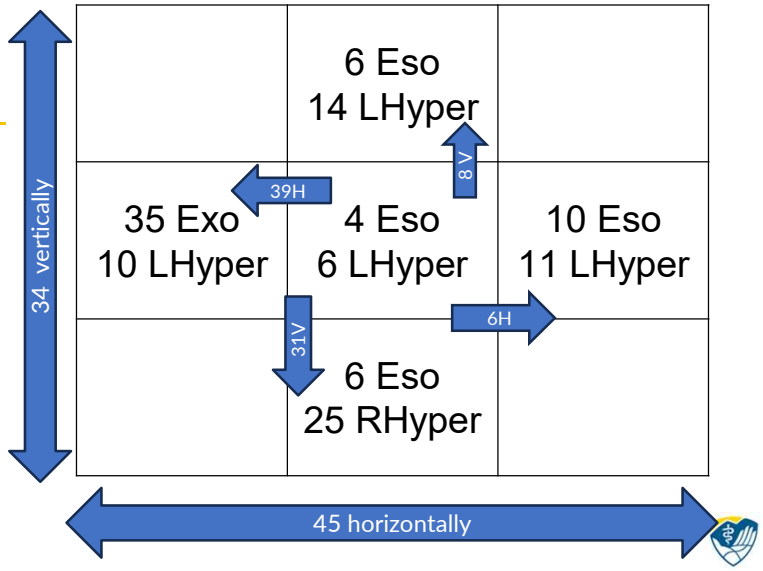
Are Deviations Comitant?

Results:

- >5pd from primary gaze to all 4 gazes
- >10pd from extreme gazes horizontally and vertically

Non-Comitant



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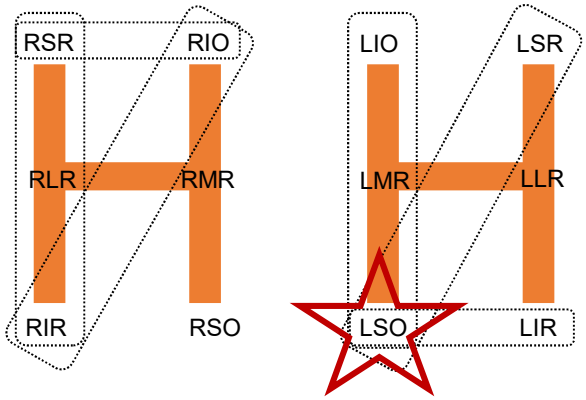
Parks 3-Step Application

Results:

- Left hyper
- Worse on right gaze
- Worse on left head tilt

Left SO Involvement



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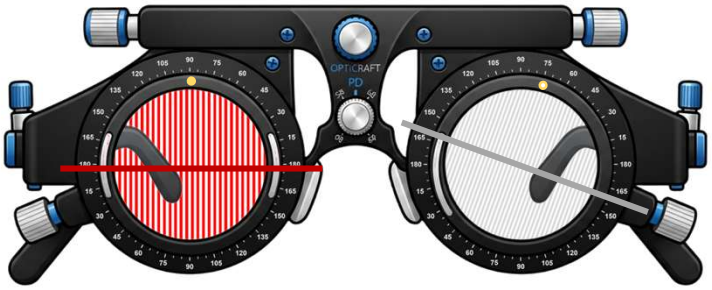
Parks 4th Step: Assessing Cyclotorsion

- Patient observes white line rotated with nasal edge going up
- Alignment at 80 degrees → 20 degrees of excyclotorsion



Confirmation of L SO Involvement

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Are The Other CNs Intact?

- Multiple cranial nerves are involved
- Primarily right sided involvement except for CN4 which decussates at midbrain
- Potential Hx of L-sided CN 5 involvement

Cranial Nerves	Assessment
1 Olfactory	Equal smell R/L
2 Optic	BCVA 20/20 OD/OS
3 Oculomotor	RUL ptosis Involvement of IO, MR, IR, SR
4 Trochlear	Involvement of LSO
5 Trigeminal	Equal sensation in all divisions R/L
6 Abducens	RLR involvement
7 Facial	Symmetry, + forced blinking
8 Vestibulocochlear	Equal auditory R/L
9 Glossopharyngeal	+ swallowing
10 Vagus	+ swallowing, + voice sounds
11 Accessory	+ Shoulder shrug, + neck rotation
12 Hypoglossal	+ tongue movement; - deviation

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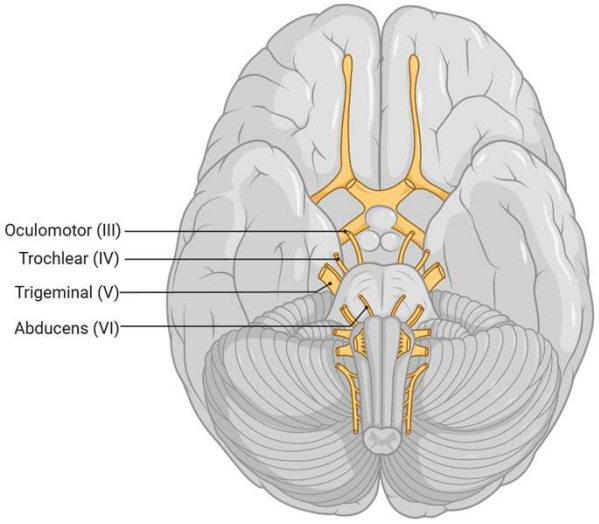
Clues → DDx

- Clues:
  - R CN3 pathway
  - R CN4 pathway (decussates at midbrain)
  - R CN6 pathway
- DDx:
  - Significant HA → Space-occupying mass?
  - R midbrain lesion?



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What's Next?

IMAGING!

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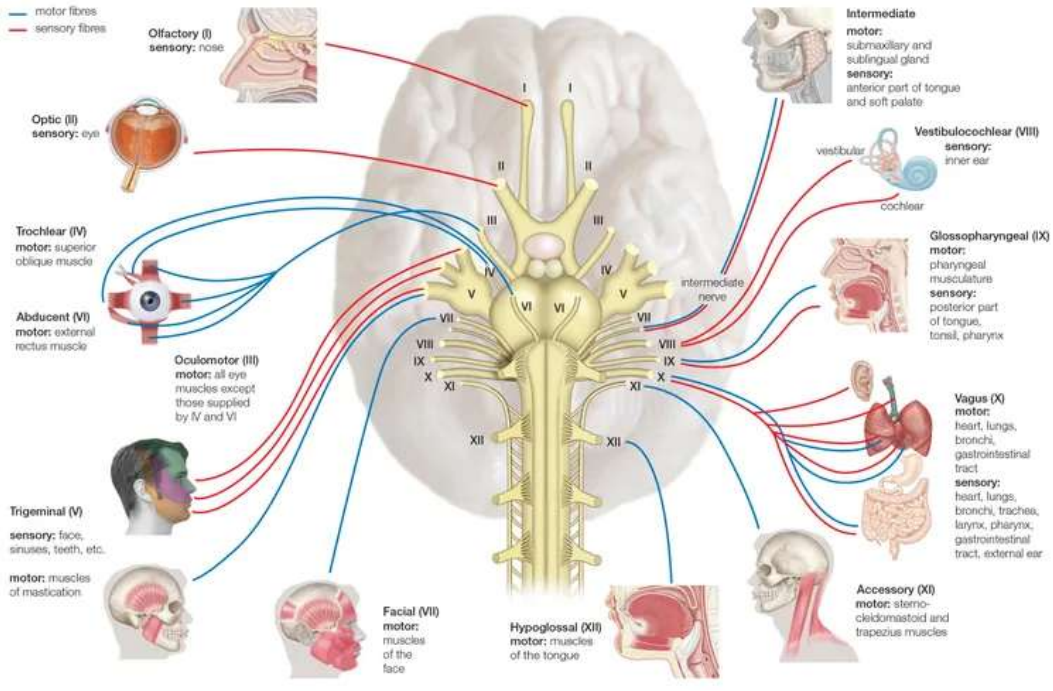

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Principles of Imaging

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Types of Radiology

- Diagnostic Radiology:
  - Use of imaging to diagnose illness and injury
  - Most applicable to eye care providers
- Interventional Radiology:
  - Use of range of imaging procedures (i.e., fluoroscopy in surgeries) to obtain images for diagnosis and interventional procedures or treatments
- Radiation Oncology:
  - Use of radiation therapy to treat and management malignant or non-malignant disease
  - Radiation therapy includes high energy X-rays, electron beams, and gamma rays

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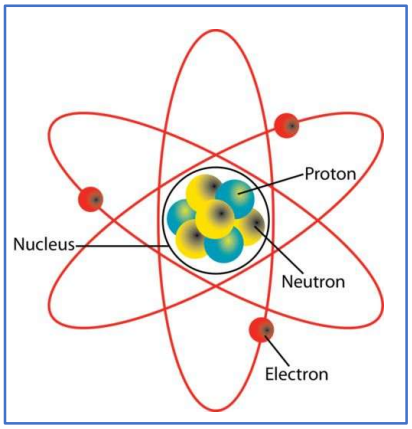
Physics of Radiographs: The Original



- ***ATOMS are the basis of radiographs.***
- ***Recall:***
  - Atoms are made of subparticles: neutrons, protons, and electrons.
  - The particle of the atomic nucleus of the atom contains neutrons and protons called nucleons. A bundle of nucleons makes up the nucleus.
  - Generation of energy:
    - Electrons are position at different energy levels called atomic orbits. Electrons can move from one energy level emitting energy.
    - Energy can be emitted from protons.

https://energywavetheory.com/atoms/nucleus-structure/

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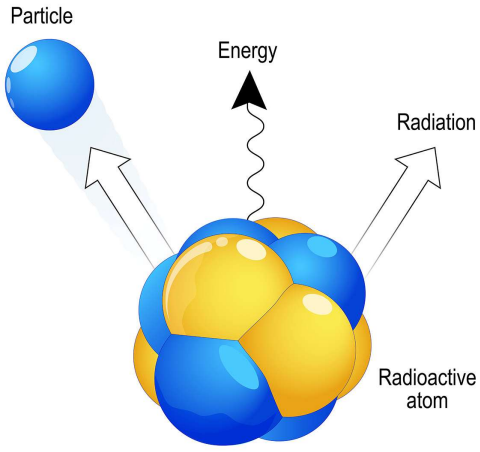
Atom Stability

- ***Stable Atoms***
  - Good ratio of neutrons and protons
  - Has enough binding energy to hold the nucleus together
- Unstable Atoms (Radioactive):
  - Improper balance of neutrons and protons
  - To become more stable, atom will release energy from the nucleus as a particle or ray.
    - Energy released results in radiation.
    - Nucleus composition changes resulting in a different element. This process is called radioactive decay.



https://www.cdc.gov/radiation-health/about/radioactive-atom.html

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Classification of Radiation

Non-Ionizing Radiation

- Due to insufficient energy, non-ionizing radiation cannot remove electrons.
- Lower energies (lower frequencies/ longer wavelengths) up until UV results in non-ionizing radiation.
- Non-ionizing radiation have not been found to result in cancer, but high heat can cause tissue damage.
- Example is heat from the microwave and cellular data.

Ionizing Radiation

- Form of energy that can remove electrons from atoms and molecules of material where the material can be air, water, or living tissue.
- Higher energy (higher frequencies / shorter wavelengths) can result in ionizing radiation.
- Results in damage at a cellular level particularly DNA
- Examples include X-rays and CT.

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Radiation Exposure & Safety

- Ionizing radiation from environment or man-made devices can result in tissue damage, even death.
- Linear dose-response relationship to the development of cancer
  - Well-established that high dose ionizing radiation can increase risk of cancer[1]
  - Newer research suggesting that low-dose exposure can increase risk of cancer[2]
- Protection includes:
  - Justification: What is the risk/benefit ratio?
  - Optimization (As Low As Reasonably Achievable): Aim for the lowest exposure that is reasonably achievable.
  - Dose limitations:
    - Recommendation from the International Commission of Radiological Protection
    - Put in place to ensure that individuals are not exposed to an unnecessary amount of ionizing radiation

1. Kelly-Reif K, Bertke SJ, Daniels RD, Richardson DB, Schubauer-Berigan MK. Ionizing radiation and solid cancer mortality among US nuclear facility workers [published correction appears in Int J Epidemiol. 2024 Feb 1;53(1):dyae025. doi: 10.1093/ije/dyae025.]. *Int J Epidemiol*. 2023;52(4):1015-1024. doi:10.1093/ije/dyad075
2. Hauptmann M, Daniels RD, Cardis E, et al. Epidemiological Studies of Low-Dose Ionizing Radiation and Cancer: Summary Bias Assessment and Meta-Analysis [published correction appears in J Natl Cancer Inst Monogr. 2023 May 4;2023(61):e1. doi: 10.1093/jncimonographs/lgac027.]. *J Natl Cancer Inst Monogr*. 2020;2020(56):188-200. doi:10.1093/jncimonographs/lgaa010

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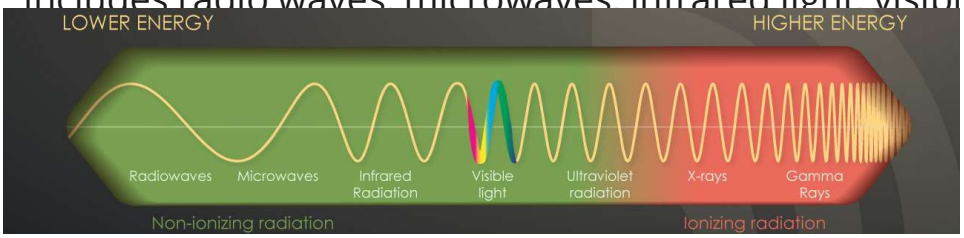
Electromagnetic Radiation (EMR)

- Photons are the smallest possible particle of electromagnetic energy hence light.
- EMR is a matterless bundle of energy that travels in a wave-form through space that emits photons.
- EMR can vary in strength from low energy to high energy. It includes radio waves, microwaves, infrared light, visible



https://www.cancer.gov/publications/dictionaries/cancer-terms/def/electromagnetic-radiation; https://www.cdc.gov/radiation-health/about/electromagnetic-spectrum.html

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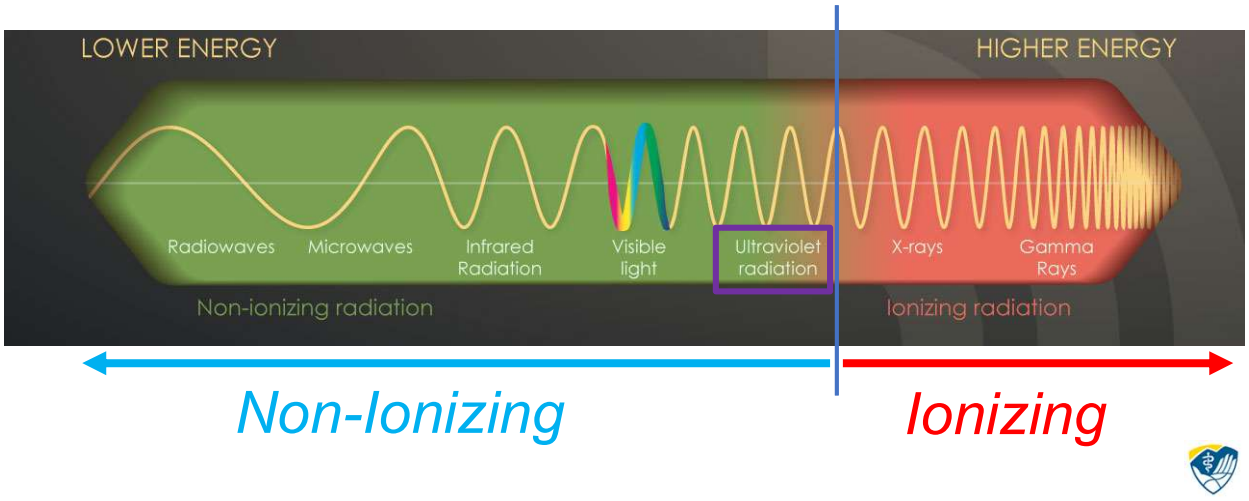
Electromagnetic Spectrum



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Radiology Imaging Terminology

Modalities

vs

Sequences

Imaging modality refers to the technique used to obtain images of the body grossly (e.g., whole body, organs) or cellular and molecular level.

The following are all imaging modalities:

- Conventional radiography / X-rays
- Computed tomography
- Magnetic resonance imaging
- Nuclear scans
- Functional magnetic resonance imaging

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Radiology Imaging Terminology

Modalities

vs

Sequences

Imaging sequence refers to a specific set of instructions or steps that an imaging equipment follows to acquire images. Sequences are most common with MRIs which will differ from sequences of other imaging modalities.

Parameters or features includes (but not limited to):

- Weighted images (T1- versus T2-)
- Fluid attenuated inversion recovery (FLAIR)
- Diffusion weighted imaging (DWI)
- Fat suppression
- Contrast agents
- Angiography

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Imaging Modalities & Sequences

Indications and Differences

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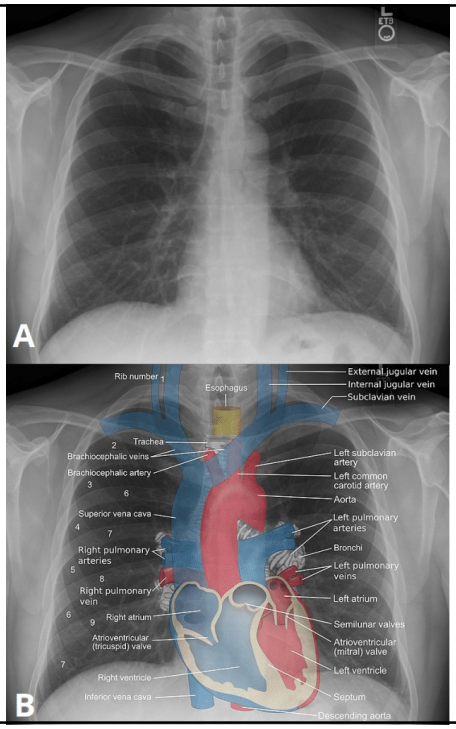
Conventional Radiographs: X-Rays

- Includes film-screen radiographs and digital radiographs
- Advantages:
  - Rapid
  - Widely available
  - Cost effective
  - Non-invasive
- Disadvantage:
  - Exposure to ionizing radiation
  - Limited soft tissue contrast

https://teachmeanatomy.info/the-basics/imaging/x-ray/



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Indications of Radiographs

- Bone:
  - Dislocation
  - Fractures or breaks
- Dense tissue:
  - Gallstones
  - Tumors/masses
  - Calcification
- Foreign objects:
  - Metal
  - Inhaled/swallowed object
- Commonly used to evaluate the chest, abdomen, teeth

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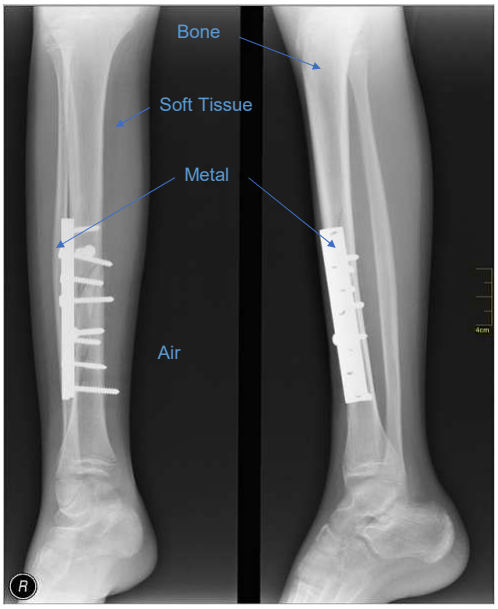
Densities of Radiographs

Interpretation is based on densities of matter where energy is directed.

Matter	Energy	Radiodensity
Metal	Rays cannot pass through	White
Bone	Rays barely pass through	
Soft Tissue	Rays somewhat pass through	Gray
Fat	Rays mostly passes through	
Air	Rays pass completely through	Black



https://letstalkscience.ca/educational-resources/backgrounders/radiography-x-ray-imaging

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Computed Tomography

- Previously known as computed axial tomography (CAT) scan
- Combination of rotating X-ray radiation and radiation detector to create a computerized cross-sectional scan
  - Cross-sectional scans, or slices, are stacked to create a 3-D image
  - Can be used for any part of the body
  - Can use contrast
- Advantages:
  - Wider array of indications
  - Elimination of overlapping images (which occurs in Xrays)
- Disadvantage:
  - More exposure to ionizing radiation than X-rays
  - Potential for patient discomfort: enclosed space, noise

File:Moderní výpočetní tomografie s přímo digitální detekcí rentgenového záření.jpg. (2023, November 30). *Wikimedia Commons*. Retrieved 00:29, May 1, 2025 from https://commons.wikimedia.org/w/index.php?title=File:Modern%C3%AD_v%C3%BDpo%C4%8Detn%C3%AD_tomografie_s_p%C5%99%C3%ADmo_digit%C3%A1ln%C3%AD_detekc%C3%AD_rentgenov%C3%A9ho_z%C3%A1%C5%99en%C3%AD.jpg&oldid=826498639.

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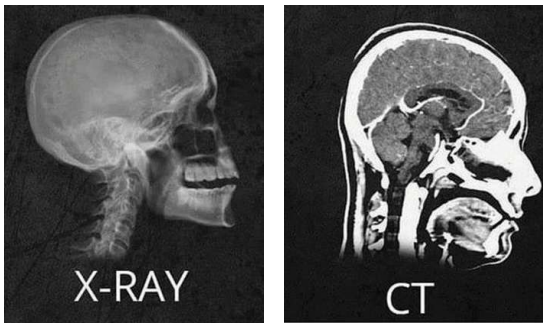
Computed Tomography: Indications

- Indications include diagnostic purposes or during procedures
- Wide array of indications
- Commonly used for *"B-B-B"*
  - (Acute) **B**lood
  - **B**one
  - **"BB"** – metal pellets
- Others:
  - Stroke
  - Tumors
  - Aneurysms
  - Infection
  - Trauma



https://sdbif.org/whats-the-difference-between-all-the-different-head-scans/

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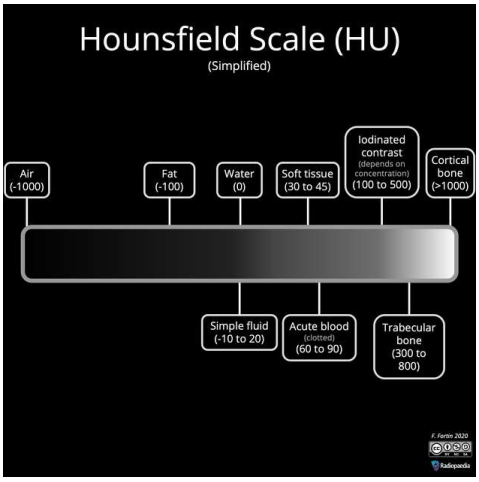
Computed Tomography: Densities

- Hounsfield scale, or Hounsfield unit (HU):
  - Standardized scale
  - Measures radiodensity of tissue in CT
- +/- Enhancement:
  - Addition of intravenous contrast material
  - Increases HU
  - Assists in normal vs abnormal tissue, diagnosis and staging of conditions, and accentuates vascularization



https://radiopaedia.org/cases/hounsfield-scale-diagram

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Magnetic Resonance Imaging

- Imaging modality using a magnetic field to recreate detailed images of tissue and structures
- Advantages:
  - MRI provides better soft tissue contrast than CT and Xrays
  - Parameters can be adjusted to improve delineation of structures
- Disadvantages:
  - Expensive
  - Can't use in a patients with metal implants or foreign bodies
  - RF can induct tissue heating, especially if presence of implants
  - Potential for patient discomfort: enclosed space, more noise than CT

https://www.dmcprimarycare.com/blog/2018/04/05/traditional-vs-open-mri-4-things-you-should-know/

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MRI: Slice Thickness

- Thickness of scans is dependent on the imaging facility
- Common slice thicknesses:
  - Neuroimaging (excluding not orbit): 2 to 5 mm
  - Neuroimaging of orbit and spine: ≤ 3.0 mm (1.0 mm is common)
  - Rest of body: 4 to 7 mm

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Units of MRI: TESLA

- Tesla (T) is the unit of measure for the magnetic field strength.
- Higher the tesla units, the stronger the magnetic field → Greater resolution, faster acquisition
- Tesla units of MRI units (most common to least common):
  - 1.5T: Preferred for whole-body
  - 3.0T: Preferred for neuroimaging and musculoskeletal studies
  - >7.5T

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MRI: Comparing Different TESLAs

Characteristics	1.5 T MRI	3.0 T MRI
Slice Thickness	Capable of thicker slices (3.0 mm)	Capable of thinner slices (< 1.8 mm)
Resolution	Lower	Higher
Image quality	Lower	Higher
Signal-to-noise ratio (SNR) (based on Teslas only)	Worse SNR	Higher SNR
Availability	More common	Less common

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Common MRI Sequences

- T1-weighted
- T2-weighted
- Fluid Attenuated Inversion Recovery (FLAIR)
- Fat suppression

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MRI Sequences: Indications and Differences

Type	Ideal For	Indications	Intensity
T1-weighted	Highlights fats and soft tissue including muscles and bone	Evaluating of anatomy Detection of masses	• Structures/tissues will appear brighter whereas fluid appears dark. • Ex: Gray matter is dark, white matter is bright, CSF is dark
T2-weighted	Highlighting fluids such as water and blood	Edema Infections Inflammation Neoplastic	• Structures/tissues will have varying degrees of darkness whereas fluid appears bright. • Ex: Gray matter is bright, white matter is dark, CSF is bright
T2 + FLAIR	Distinguishing tissue or abnormalities that involves or is adjacent to CSF	White matter disease Infarction Subarachnoid hemorrhages Head trauma	• Structures/tissues are similar in intensity to T2-weighted except CSF is dark. • Ex: Gray matter is bright, white matter is dark, CSF is dark

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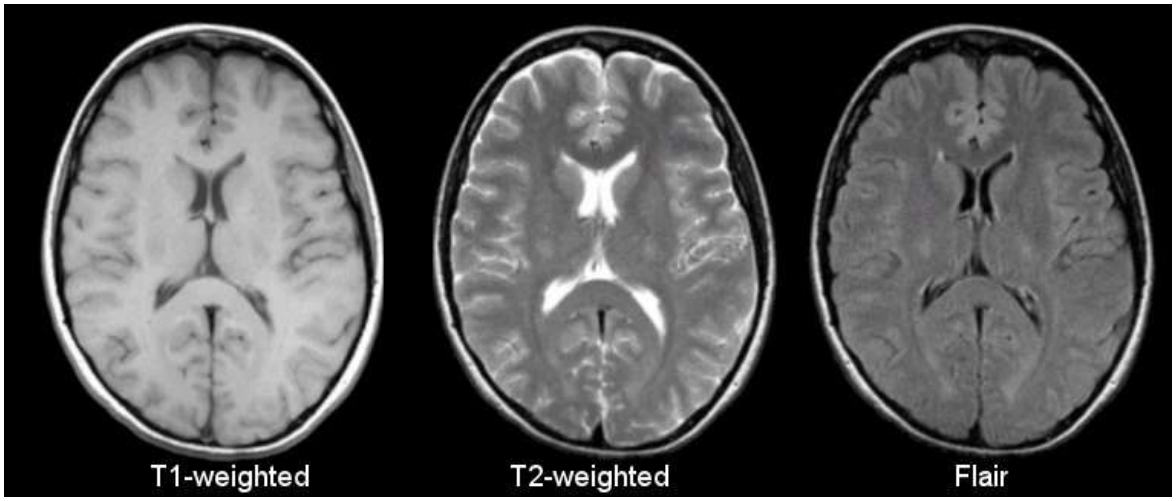

https://case.edu/med/neurology/NR/MR%20Basics.htm

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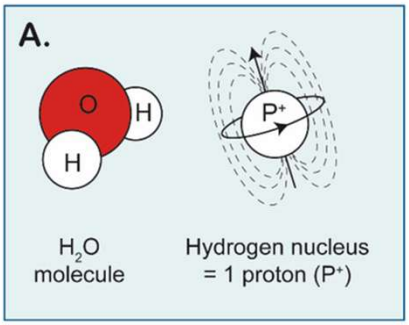
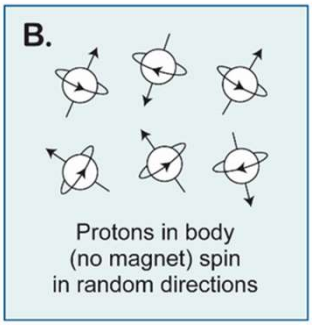
Physics of MRI

Fundamentals of MRI

- Human body is made up of cells with water content: H2O.
- The H+ is a proton with a positive and negative charge that respond to magnetic forces.
- Normally protons are randomly oriented.





https://www.researchgate.net/figure/Mechanism-of-magnetic-resonance-imaging-A-Hydrogen-atoms-are-dispersed-within-the_fig2_352367301

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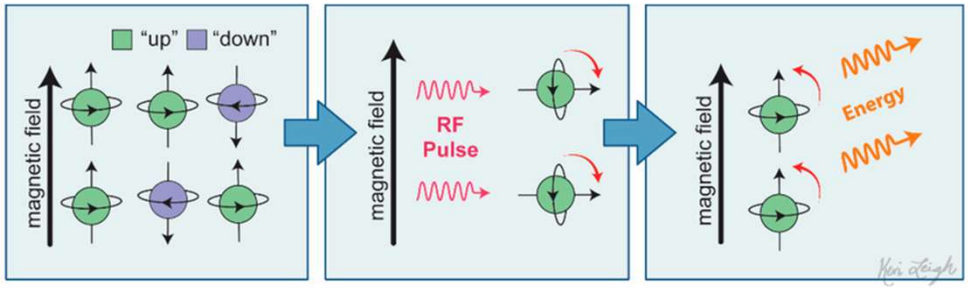
Physics of MRI

1. Once in MRI machine, magnetic field spins positively charged protons and aligns protons either parallel or anti-parallel.
2. RF excitation: Aligned protons are excited by radiofrequency pulses (RF) resulting in flipped transverse proton orientation.
3. Relaxation process: RF is turned off which causes protons to realign with the magnetic field, releasing the energy.
4. Energy is processed into MRI studies.



https://www.researchgate.net/figure/Mechanism-of-magnetic-resonance-imaging-A-Hydrogen-atoms-are-dispersed-within-the_fig2_352367301

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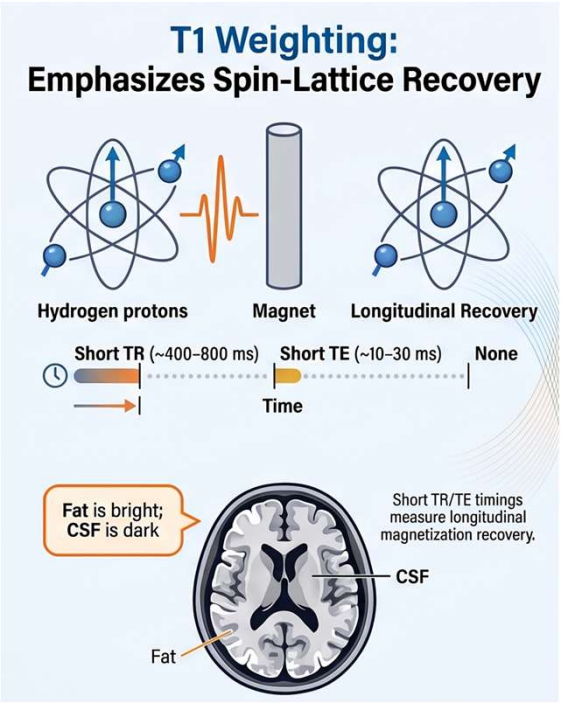
T1-Weighted MRI

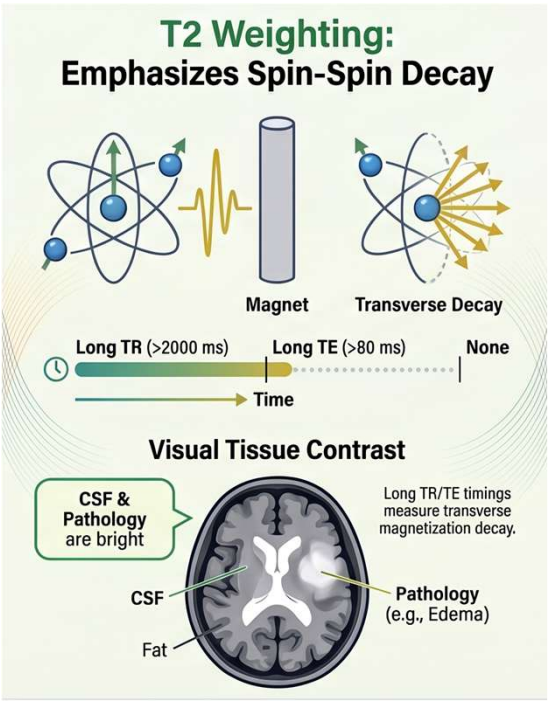
- T1 imaging asks: *"How fast do protons stand back up?"*
- Measures how quickly protons realign with the main magnetic field after the RF pulse.
- Different tissues will recover differently and with T1-imaging, differences are highlighted between tissue.
- Key tissue contrast:
  - Highlights fats/soft tissue → Appears bright
  - Fluid (e.g. CSF) → Appears dark



56

T2-Weighted MRI

- T2 imaging asks: *"How fast do protons lose synchronization?"*
- Measures how quickly protons lose phase coherence in the transverse plane
- Refers to the decay of hydrogen magnetization
- Key tissue contrast:
  - Highlights fluids (e.g. CSF) → Appears bright
  - Structures/tissues → varying degrees of darkness



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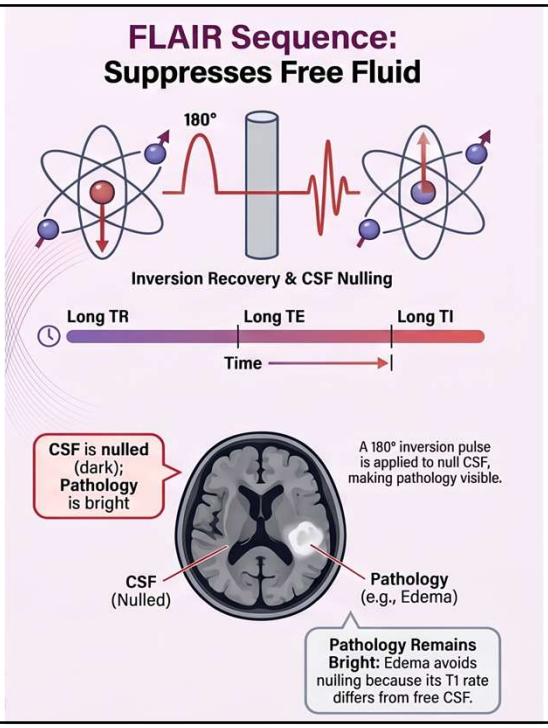
FLAIR

- FLAIR is a sequence that results in inversion recovery sequence with a long inversion time
- ***Addition to T2-weighted scans***
  - FLAIR = T2 minus CSF)
  - Nullifies signal from CSF allowing for discriminating subtle changes in the brain
- Key tissue contrast:
  - Highlights pathology (e.g. edema) → Appears bright
  - Structures/tissues → varying degrees of darkness
  - CSF → appears dark due to nullification



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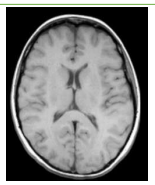
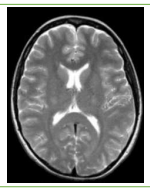
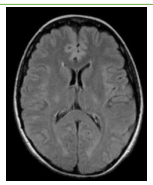
MRI Sequences: Differences Based on Tissue or Defect

Tissue	T1-Weighted	T2-Weighted	FLAIR (T2 – CSF)
CSF	Dark	Bright	Dark
Gray matter	Gray	Light gray	Light gray
White matter	Light gray	Dark gray	Dark gray
Fat	Bright	Light	Light
Muscle	Gray	Dark gray	Dark gray
Inflammation, infection, demyelination	Dark	Bright	Bright
Example: Transverse/Axial of Brain			

https://case.edu/med/neurology/NR/MRI%20Basics.htm

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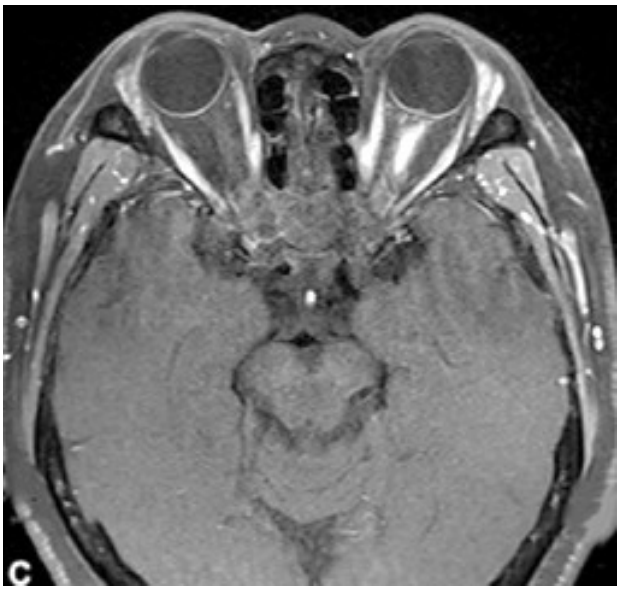
MRI Sequences: Fat Suppression

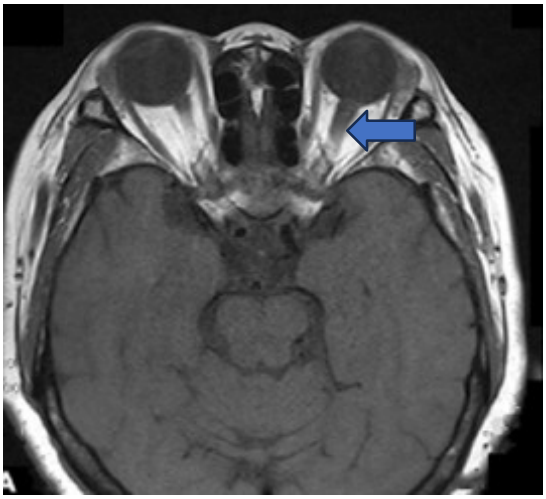
- Reduces signal from fat tissue
- Commonly performed for orbit scans
- Can be added to T1- or T2- weighted scans



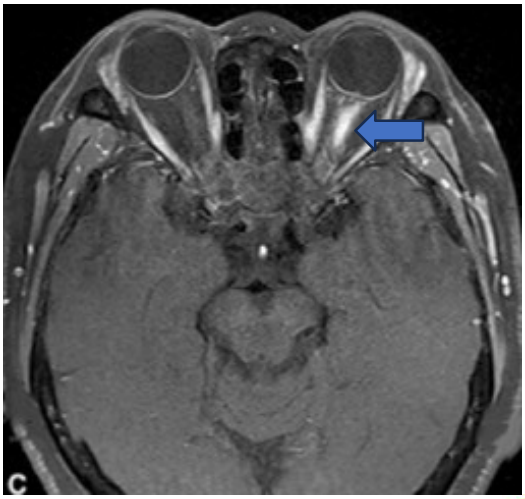
Feng, Chaoyi & Chen, Qian & Liu, Wei & Bi, Yingwen & Qian, Jiang & Sun, Xinghuai & Tian, Guohong. (2020). Neurosarcoidosis presenting as CRVO combined CRAO: A biopsy-proven case report of a Chinese patient. BMC Ophthalmology. 20. 10.1186/s12886-020-01624-5.

60

T1-Weighted



T1-Weighted with Fat Suppression



Feng, Chaoyi & Chen, Qian & Liu, Wei & Bi, Yingwen & Qian, Jiang & Sun, Xinghuai & Tian, Guohong. (2020). Neurosarcoidosis presenting as CRVO combined CRAO: A biopsy-proven case report of a Chinese patient. BMC Ophthalmology. 20. 10.1186/s12886-020-01624-5.

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MRI Contraindications

- Cardiac implantable electronic device (i.e., pacemaker)
- Metallic foreign bodies:
  - Intraocular foreign bodies
  - Fragments (i.e., bullets, pellets, metal shrapnel)
- Cochlear/ear implants
- Aneurysm clips
- Tissue expander
- Artificial limb
- Drug infusion pumps
- Piercings

Basically anything impacted by magnetic force

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Angiography

- Angiography is the imaging of blood vessels (arterial and venous)
- Two types:
  - Invasive:
    - Digital subtraction angiography performed with X-rays
  - Non-invasive:
    - CT angiography (CTA)
    - MR angiography (MRA)
    - Color doppler

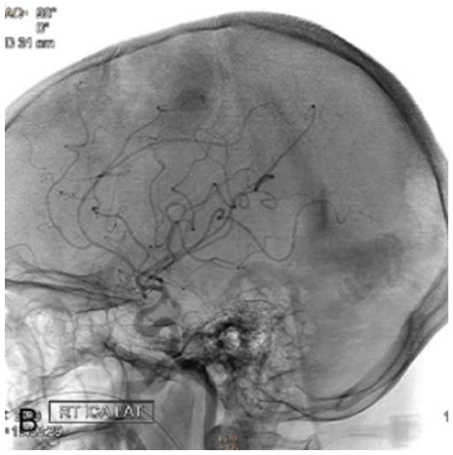

Figure 1.11.7. Gulati, Praveen, et al. Comprehensive Textbook of Clinical Radiology Volume I: Principles of Clinical Radiology, Multisystem Diseases & Head and Neck. Available from: VitalSource Bookshelf, Elsevier Australia, 2023.

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Angiography: Common Indications

- Head & Neck
  - Aneurysms
  - Vascular malformation
  - Carotid-cavernous sinus fistula
  - Tumors
  - Trauma
  - Subarachnoid hemorrhage
  - Stroke
  - Ischemia
- Peripheral
  - Deep venous thrombosis
  - Vascular malformation
- Cardiothoracic
  - Aortic evaluation
  - Pulmonary
- GI:
  - GI bleeding
  - Renal beeding

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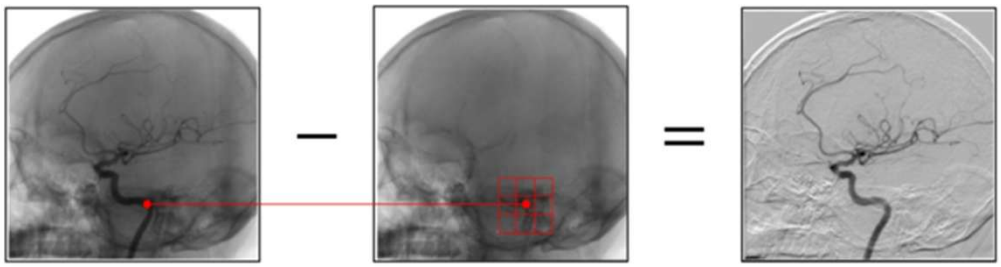
Invasive Angiography: Digital Subtraction Angiography

- A form of interventional radiology that typically requires contrast with iodine
- Invasive fluoroscopic technique used in conjunction with X-rays that utilizes contrast
- Real-time imaging where a pre-contrast image is taken and then subtracted from post-contrast images



https://www.researchgate.net/figure/Illustration-of-traditional-digital-subtraction-angiography-DSA-ie-DSAI-C-I-BG-in_fig1_382882213

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Noninvasive Angiography: MRA

- A form of interventional radiology:
  - MRA is ***PREFERRED*** over CTA for evaluating neurovascular pathology and for assessing the details of the blood vessel walls
  - Commonly used to evaluate the neuro-vasculature of the neck
- Noninvasive, non-ionizing radiation
- Can be performed with or without contrast

https://www.europeanhhm.com/articles/know-the-difference-ct-angiography-cta-and-mri-angiography-mra#:~:text=Clinical%20Applications:%20CTA%20is%20commonly,stenosis%2C%20and%20soft%20tissue%20perfusion.

66

Noninvasive Angiography: CTA

- A form of interventional radiology:
  - CTA is the most common modality for neurovascular anatomy (but MRA is favored for neurovascular)
    - *WHY?*
  - CTA is preferred for aortic or pulmonary embolisms
  - CTA is frequently used to evaluate the peripheral vasculature system
- Noninvasive but uses ionizing radiation
- Majority of CTA scans requires contrast agent

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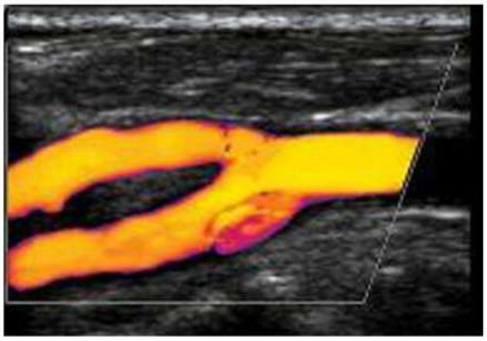
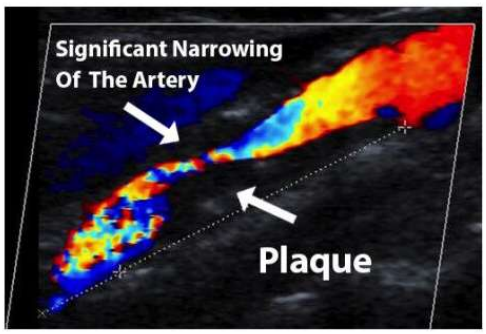
Ultrasound

- Utilization of **sound waves** to various frequencies to generate an image
- Applications:
  - Echocardiogram
  - Tissue/organ specific (i.e., breast, abdomen, pelvic, ocular, temporal artery)
  - Color dopplers (i.e., carotid dopplers)





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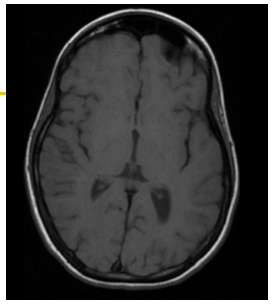
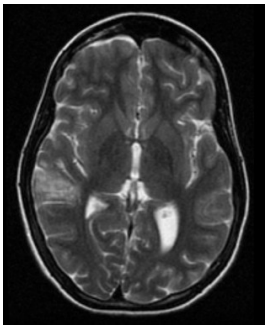
Contrast

- Agents or media with the purpose of improving discernment between objects
  - Usually intravenous but can be oral depending on test/organ
  - All imaging modalities have the option to add contrast
- Types:
  - Positive contrast: Agents that absorb more energy, appearing brighter on images (i.e., gandolinium, iodine)
  - Negative contrast: Agents that allow increased passage of energy, appearing darker or more transparent (i.e. air, CO2)
  - Neutral contrast: Agents that have similar attenuation to water
- Most common: Gadolinium, iodine
- Others: Barium sulfate, water, CO2, microbubble agents, paramagnetic or superparamagnetic agents



Without Contrast



With Contrast

https://radiologyblog.cincinnatichildrens.org/cincinnati-childrens-continues-high-quality-of-care-with-new-mri-contrast/

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Most Common Contrast Agents

Agent	Imaging Modalities	Considerations	Adverse Events
Iodine	CT, X-rays, angiograms, GI studies	• Useful in making hollow structures (i.e., blood vessels, GI tract, subarachnoid space, joints) visible on imaging studies • Potential contraindications: o Previous allergic reaction to iodine contrast o Severe renal disease o Active, untreated thyrotoxicosis o Active myasthenia gravis	• Contrast extravasation (leakage) • Urticarial skin reaction or anaphylactic-like reaction
Gandolinium	MRI, MRA	• Particularly useful for MRI of brain and spinal cord • Potential contraindications: o Previous allergic reaction to gandolinium o Severe renal impairment o Pregnancy	• Injection site warmth/coldness • Headaches/nausea/dizziness • Contrast extravasation (leakage) • Urticarial skin reaction or anaphylactic-like reaction

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The Before & After of Imaging

Orders, Interpretation, and Reports

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Imaging Orders: Considerations

Patient Considerations

- Any relative/absolute contraindication to consider:
  - Allergies or prior reactions to contrast agents or radiotracers
  - Claustrophobia
  - Metal objects (i.e. pacemaker, cochlear implants)
- Consider the financial responsibility:
  - Is the patient insured?
  - If not, can patient afford it?

Imaging Considerations

- Consider how you will refer for imaging (i.e. paper form, electronic portal)
- Urgency of report
- Concise, pertinent patient history
- Indication of specific parameters. For example: scans of orbit
  - Indicate 1.0 mm slice thickness or indicate thin cut/high definition
  - Aim for a 3.0 T but know there is higher signal-to-noise (SNR)

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Unsure Which Modality / Sequence?

Imaging Modality / Sequence	CSF / Fluid Signal	Fat Signal	Soft Tissue / Muscle Signal	Primary Clinical Indications
Radiographs	Pass-through (Dark/Gray)	Passes mostly (Dark Gray)	Somewhat passes (Gray)	Bone fractures/dislocations, calcifications, dense masses, metallic foreign bodies
Computed Tomography	Simple fluid (-10 to 20 HU (Dark)	Low density (-100 HU, Dark Gray)	Mid density (30 to 45 HU, Gray)	"B-B-B" (Acute Blood, Bone injuries, Metallic BBs/Pellets), trauma, acute stroke, aneurysms
T1-Weighted MRI	Dark	Bright	Gray / Light Gray	Detailed structural anatomy, mass detection, fat & soft tissue delineation
T2-Weighted MRI	Bright	Light / Bright	Gray / Dark Gray	Fluid pathology, edema, acute infections, soft tissue inflammation, demyelination (MS)
MRI with Fat Suppression	Dependent on T1/T2 weighting	Nulled (Dark)	Delineated Gray	Nulling orbital/retrobulbar fat signal to reveal optic nerve & orbital lesions
MRI with FLAIR	Nulled (Dark)	Light / Bright	Gray / Light Gray	Periventricular lesions, cerebral infarctions, subarachnoid hemorrhages, CNS demyelination

Gemini Notebo

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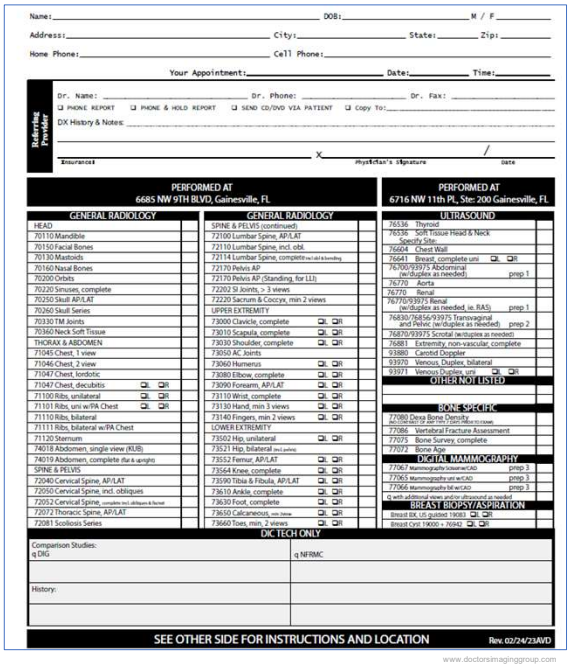
Imaging Orders: Required Elements

- Patient information (i.e. name, age, race)
- Indicate imaging modality:
  - Tissue being imaged
  - +/- contrast
- Clinical indication / ICD-10
- Physician's name and signature



Name: _____ DOB: _____ M / F _____

Address: _____ City: _____ State: _____ Zip: _____

Home Phone: _____ Cell Phone: _____

Your Appointment: _____ Date: _____ Time: _____

Referring Provider

Dr. Name: _____ Dr. Phone: _____ Dr. Fax: _____

❑ PHONE REPORT ❑ PHONE & HOLD REPORT ❑ SEND CD/DVD VIA PATIENT ❑ Copy To: _____

DX History & Notes: _____

Insurance _____ X _____ Physician's Signature _____ / Date

PERFORMED AT 6685 NW 9TH BLVD, Gainesville, FL

GENERAL RADIOLOGY

HEAD
70110 Mandible
70150 Facial Bones
70130 Mastoids
70160 Nasal Bones
70200 Orbits
70220 Sinuses, complete
70250 Skull AP/LAT
70260 Skull Series
70330 TM Joints
70360 Neck Soft Tissue
THORAX & ABDOMEN
71045 Chest, 1 view
71046 Chest, 2 view
71047 Chest, kyndotic
71047 Chest, decubitis ❑L ❑R
71100 Ribs, unilateral ❑L ❑R
71101 Ribs, uni w/PA Chest ❑L ❑R
71110 Ribs, bilateral
71111 Ribs, bilateral w/PA Chest
71120 Sternum
74018 Abdomen, single view (KUB)
74019 Abdomen, complete (flat & upright)
SPINE & PELVIS
72040 Cervical Spine, AP/LAT
72050 Cervical Spine, incl. obliques
72052 Cervical Spine, complete incl. obliques & flexion
72072 Thoracic Spine, AP/LAT
72081 Scoliosis Series

GENERAL RADIOLOGY

SPINE & PELVIS (continued)
72100 Lumbar Spine, AP/LAT
72110 Lumbar Spine, incl. obl.
72114 Lumbar Spine, complete incl. obl & bending
72170 Pelvis AP
72170 Pelvis AP (Standing, for LLI)
72202 SI Joints, > 3 views
72220 Sacrum & Coccyx, min 2 views
UPPER EXTREMITY
73000 Clavicle, complete ❑L ❑R
73010 Scapula, complete ❑L ❑R
73030 Shoulder, complete ❑L ❑R
73050 AC Joints
73060 Humerus ❑L ❑R
73080 Elbow, complete ❑L ❑R
73090 Forearm, AP/LAT ❑L ❑R
73110 Wrist, complete ❑L ❑R
73130 Hand, min 3 views ❑L ❑R
73140 Fingers, min 2 views ❑L ❑R
LOWER EXTREMITY
73502 Hip, unilateral ❑L ❑R
73521 Hip, bilateral (incl. pelvis)
73552 Femur, AP/LAT ❑L ❑R
73564 Knee, complete ❑L ❑R
73590 Tibia & Fibula, AP/LAT ❑L ❑R
73610 Ankle, complete ❑L ❑R
73630 Foot, complete ❑L ❑R
73650 Calcaneous, uni. bone ❑L ❑R
73660 Toes, min. 2 views ❑L ❑R

PERFORMED AT 6716 NW 11th PL, Ste: 200 Gainesville, FL

ULTRASOUND

76536 Thyroid
76536 Soft Tissue Head & Neck Specify Site:
76604 Chest Wall
76641 Breast, complete uni ❑L ❑R
76700/93975 Abdominal (w/duplex as needed) prep 1
76770 Aorta
76770 Renal
76770/93975 Renal (w/duplex as needed, ie. RAS) prep 1
76830/76856/93975 Transvaginal and Pelvic (w/duplex as needed) prep 2
76870/93975 Scrotal (w/duplex as needed)
76881 Extremity, non-vascular, complete
93880 Carotid Doppler
93970 Venous, Duplex, bilateral
93971 Venous, Duplex, uni ❑L ❑R

OTHER NOT LISTED

BONE SPECIFIC

77080 Dexa Bone Density (NO CONTRAST OF ANYTHING 7 DAYS PRIOR TO EXAM)
77086 Vertebral Fracture Assessment
77075 Bone Survey, complete
77072 Bone Age

DIGITAL MAMMOGRAPHY

77067 Mammography Screener/CAD prep 3
77065 Mammography Unil w/CAD prep 3
77066 Mammography Bil w/CAD prep 3
❑ with additional views and/or ultrasound as needed

BREAST BIOPSY/ASPIRATION

Breast BX, US guided 19083 ❑L ❑R
Breast Cyst 19000 + 76942 ❑L ❑R

DIC TECH ONLY

Comparison Studies: q DIG	q NFRMC
History:	

SEE OTHER SIDE FOR INSTRUCTIONS AND LOCATION Rev. 02/24/23AVD

www.doctorsimaginggroup.com

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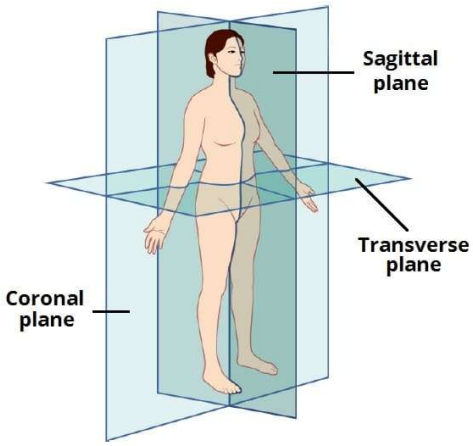
Positioning Terminology: Planes

- **Transverse/Axial plane:**
  - Horizontal plane is parallel to the ground
  - Divides the body into superior and inferior parts
- **Sagittal plane:**
  - Vertical plane that passes through the body longitudinally
  - Divides the body into right and left halves
- **Coronal plane:**
  - Vertical plane perpendicular to the median plane
  - Divides the body into anterior and posterior parts



https://teachmeanatomy.info/the-basics/anatomical-terminology/planes/

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Radiologists Role

General

- Based on the clinical indication, radiologist may add/change imaging modality and sequences
- Communications:
  - Phone call report
  - Faxed report
  - Portal
- Imaging studies:
  - Electronic portal
  - CD/DVD with patient

Elements of Report

- Patient demographic (i.e. age, gender, occupation)
- Referral information
- Pertinent clinical history and examination findings
- Radiologic technique and adverse events
- Observation
- Interpretation
- Impression
- Suggested management

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[NationalRad Sample Neuroradiology Report]

NATIONALRad
SPECIALISTS IN DIAGNOSTIC IMAGING

Imaging Center
123 Main Street
Anywhere, USA 01234
Phone 123.456.7890
Fax 123.456.7890

PATIENT:	JOHN SMITH
DOB:	5/5/1955
FILE #:	12345
PHYSICIAN:	REFERRING
EXAM:	MRI BRAIN WITH AND WITHOUT CONTRAST
DATE:	1/1/2011

CLINICAL INFORMATION

Right arm weakness. Difficulty expressing thoughts in writing beginning about 4-5 months ago.

COMPARISON

No comparison.

CONTRAST

16 cc of MultiHance administered without complication.

TECHNIQUE

Sagittal and axial T1-weighted images, axial FLAIR images, axial diffusion weighted sequences, axial T2-weighted images and coronal gradient echo sequences of the brain were obtained. Following gadolinium administration axial and coronal T1-weighted images were obtained.

FINDINGS

Evaluation of the brain demonstrates a prominent bilobed right and especially left-sided paramedial extra-axial mass centered overlying the posterior frontal and anterior parietal lobes. The mass demonstrates heterogeneous signal but homogeneous enhancement with mildly irregular but smooth contours. The mass measures approximately 5.8 x 58 x 4.2 CM (anterior posterior by transverse by superior-inferior). The mass encases the falx and the adjacent superior sagittal sinus with evidence of marginal dural thickening, especially extending posteriorly in the midline splaying the upper leaves of the falx through the level of the upper occipital lobe.

Prominent reactive changes noted involving the periventricular and subcortical white matter of the left frontal and

Sample Report

parietal lobes with a small amount also involving the right posterior frontal lobe. There is adjacent mass effect without significant lateral shift and no herniation.

A smaller enhancing extra-axial mass more suggestive of atypical meningioma is seen overlying the right mid temporal lobe measuring 1.3 x 0.6 CM. (Axial series 12 image 26).

There is no significant end vessel ischemic small vessel disease.

There is no acute infarct seen. No intracranial hemorrhage is recognized.

There is no parenchymal mass or mass effect.

A developmental venous anomaly is suggested within the left parietal lobe.

The ventricles, sulci and basal cisterns appear unremarkable.

The vertebral and internal carotid arteries demonstrate expected flow voids indicating their patency.

The central skull base and temporal bones are intact. The calvarium appears unremarkable. The orbits are unremarkable.

The paranasal sinuses demonstrate mucosal thickening partially outlining anterior and posterior ethmoid air cells and the right and left antrum with a hyperplastic polypoid component along the floor. No air-fluid levels are noted.

The nasal cavity appears unremarkable. The nasopharynx is symmetric.

IMPRESSION

1. Prominent bilobed paramedial extra-axial mass along the convexity centered at the level of the posterior frontal and anterior parietal lobes with prominent posterior dural tail and occlusion of the adjacent superior sagittal sinus. Prominent surrounding reactive edema, left greater than right. Mild lateral shift but no herniation. Smaller extraaxial mass overlying the right mid temporal lobe.

2. Atypical meningioma including hemangiopericytoma or variant or malignant subsidence of meningioma. Other less likely considerations include extra-axial dural based metastasis, lymphoma and less likely solitary fibrous tumor.

3. Discussed with Dr. REFERRING at 1630 hrs.

[NationalRad Neuroradiologist]
Board Certified Radiologist

THIS REPORT WAS ELECTRONICALLY SIGNED

Sample Report

https://nationalrad.com/radiology/reports/

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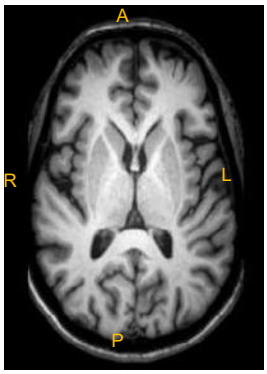
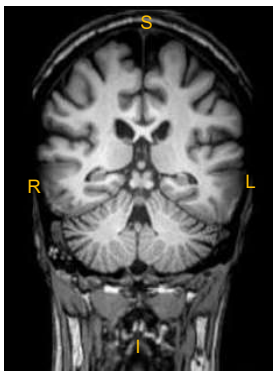
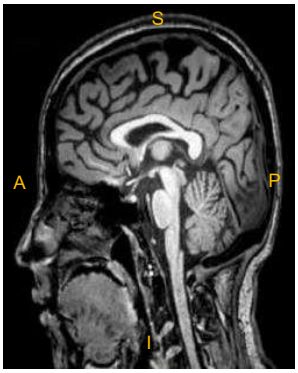
Orientation of Radiologic Images



Transverse/Axial



Coronal



Sagittal

https://www.researchgate.net/figure/MRI-planes-for-MRI-head-scan-a-Axial-b-Coronal-c-Sagittal-MR-scanner-can-generate_fig2_338448026

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Orienting You to Scan

- Useful way to remember orientation of R vs. L on axial and coronal scans
- You are standing facing the patient.
- You push the patient onto their back.
- You are now standing at their feet, still facing the patient.

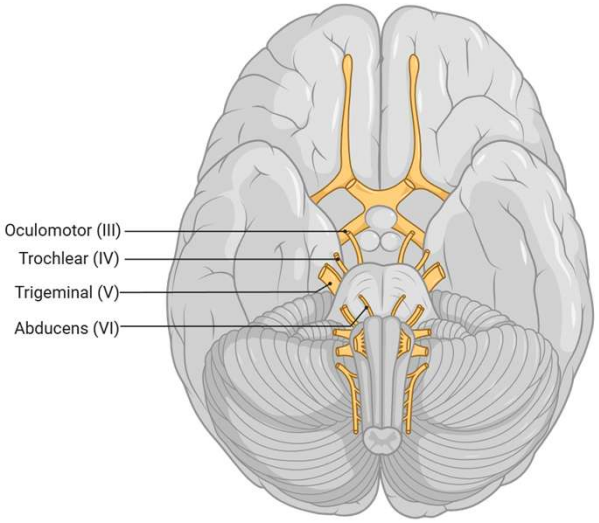
79

47 HM
"Droopy eyelid and double vision"

80

Clues → DDx

- Clues:
  - R CN3 pathway
  - R CN4 pathway (decussates from L side at midbrain)
  - R CN6 pathway
- DDx:
  - Significant HA → Space-occupying mass?
  - R midbrain lesion?



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Diagnostic Approach

- Multiple cranial nerves of the right side
- Prior hx of CN 5/7 involvement
- Neuroimaging:
  - MRI of brain/orbit
  - With and without contrast

IMAGING ORDERS

Patient Name: Patient JS
DOB: XX-XX-1979
Phone:
Insured Name:
Plan Name:
Plan # / Group #:
Delivery (In Addition to Portal): ☐ CD ☑ Fax Report ☐ Stat Phone Call:
Dx/ICD-10: G52.7 Disorders of multiple cranial nerves
Ordering Date: 05.22.2026
Office Name: RMU Eye Institute
Office Phone: 385-248-5550
Office Fax: 385-248-5510
Provider Name: Zanna Kruoch
NPI:
Signature:

CPT	MRI
70551	BRAIN W/O
70553	BRAIN W+W/O CONTRAST
70553	PITUITARY W+W/O
74183	ABDOMEN W+W/O CONTRAST
77049	BREAST BILATERAL W+W/O
73721	KNEE W/O
70553	IAC W+W/O
72156	CERVICAL SPINE W+W/O
72141	CERVICAL SPINE W/O
73718	FOOT W/O CONTRAST R L
73721	ANKLE W/O CONTRAST R L
73221	WRIST W/O CONTRAST R L
73221	ELBOW W/O CONTRAST R L
73723	HIP W/ + W/O CONTRAST R L
73218	HAND W/O CONTRAST R L
72146	THORACIC SPINE W/O
72157	THORACIC SPINE W+W/O
72148	LUMBAR SPINE W/O
72158	LUMBAR SPINE W+W/O CONTRAST
72197	PELVIS W + W/O
72195	PELVIS W/O
73221	SHOULDER W/O
73222	SHOULDER IA GAD
70543	MRI ORBITS W+W/O CONTRAST
70540	MRI ORBITS W/O CONTRAST
73723	MRI HIP W+W/O CONTRAST R L
73721	MRI HIP W/O CONTRAST
70543	MRI NECK SOFT TISSUE W+ W/O CON

CPT	MRA
70547	MRA NECK W/O CONTRAST
73725	LOWER EXTREMITY RUN-OFF W/WO
74185	MRA ABDOMEN W+W/O
70544	MRA CIRCLE OF WILLIS BRAIN W/O
71555	MRA CHEST WITH CONTRAST
71555	MRA CHEST W+W/O CONTRAST

CPT	CT
74176	ABDOMEN & PELVIS W/O CON
74177	ABDOMEN & PELVIS W/CON ONLY
74178	ABDOMEN & PELVIS W+ W/O CON
74150	ABDOMEN W/O
74160	ABDOMEN W
74170	ABDOMEN W+W/O
72192	PELVIS ONLY W/O
72193	PELVIS WITH CONTRAST ONLY
74176	RENAL STONE PROTOCOL
71260	CHEST W/CON ONLY
71250	CHEST W/O
71250	HIGH RESOLUTION CHEST W/O
70450	BRAIN W/O
70470	BRAIN W+W/O
70486	SINUS W/O CONTRAST
70491	SOFT TISSUE NECK W/CONTRAST
72125	CERVICAL SPINE W/O CONTRAST
72131	LUMBAR SPINE W/O CONTRAST
70487	CT SINUS W/CONTRAST
70488	CT SINUS W – W/O CONTRAST
72132	LUMBAR MYELOGRAM
72126	CERVICAL MYELOGRAM
72129	THORACIC MYELOGRAM

CPT	CTA
70496	ANGIO HEAD
70498	ANGIO CAROTID
74175	ANGIO ABDOMEN
75635	ANGIO AORTA WITH FEMORIAL RUN OFF
71275	ANGIO CHEST

CPT	XRAYS
73046	CHEST-PA/LAT 2 VIEWS
74018	KUB
72040	CERVICAL 2 VIEWS
72100	LUMBAR 2 VIEWS
74021	ABDOMINAL SERIES INCLUDING

Other (include CPT)

CPT	PET CT
78608	PET CT BRAIN WITH AMYVID
78816	PET CT SODIUM FLUORIDE BONE SCAN
78816	PET CT SCAN WHOLE BODY
78815	PET CT SCAN EYES TO THIGHS
78608	PET CT BRAIN WITH FDG (DEMENTIA SEIZURES)

CPT	NUCLEAR MEDICINE
	BONE SCAN (WHOLE BODY), BONE 3
78306	PHASE
78315	BONE/JOINT SCAN, BONE 3 PHASE
78320	BONE SPECT
78014	THYROID SCAN AND UPTAKE
78709	RENAL SCAN
78215	LIVER SPLEEN SCAN
78598	LUNG SCAN (V.Q. SCAN)

CPT	ULTRASOUND
76700	ABDOMEN COMPLETE
76770	ABDOMEN W/DOPPLER
76775	ABDOMINAL AORTA
93923	ARTERIAL LOWER/UPPER ABI (MULTIPLE)
93922	ARTERIAL LOWER/UPPER ABI (SINGLE)
93925	ARTERIAL LOWER BILATERAL
93922	ARTERIAL LOWER BILATERAL W/ABI
93923	ARTERIAL LOWER BILATERAL W/SEG PRESSURES
93926	ARTERIAL LOWER UNILATERAL
93930	ARTERIAL UPPER BILATERAL
93931	ARTERIAL UPPER UNILATERAL R L
76819	BIOPHYSICAL PROFILE
76641	BREAST BILATERAL R L
76641	BREAST UNILATERAL
93880	CAROTID DOPPLER
76705	LIVER W/DOPPLER R L
76770	RETROPERITONEAL COMPLETE W/DOPPLER
76536	THYROID/PARATHYROID
76770	RETROPERITONEAL COMPLETE
76770	RETROPERITONEAL COMPLETE W/DOPPLER
76536	THYROID/PARATHYROID R L

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Imaging Report

- Closed 1.5 Tesla MRI of brain and orbit w/ + w/o gadolinium contrast
- T1- and T2-weighted images

FINDINGS:
VENTRICULAR SYSTEM: Normal in size and configuration for age.
No focal atrophy or significant volume loss.

BRAINSTEM AND POSTERIOR FOSSA: No brainstem or posterior fossa lesion.
BRAIN PARENCHYMA: No focal brain parenchymal signal abnormality. No restricted diffusion. No signal dropout/blooming artifact on blood sensitive gradient series to suggest blood products in the brain or extra-axial spaces. No areas of pathologic contrast enhancement. No masses or enhancing lesions.

EXTRA-AXIAL SPACES: No hemorrhage or extra axial fluid collections. No pathologic enhancement of the meninges or meningeal based mass lesions.
BASILAR CISTERNS: Patent. Proximal cerebral vasculature is patent. Normal flow voids.

PARANASAL SINUSES AND MASTOID AIR CELLS: Clear.
EXTRACRANIAL SOFT TISSUES AND CALVARIUM: Within normal limits. No fracture or bone lesion.

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Imaging Report

ORBITS: There is a focal area of abnormal enhancement in the posterior left lateral orbit measuring 11 x 8 mm. This enhancing lesion is along the posterior left lateral margin of the left optic nerve near the orbital apex. There are surrounding inflammation and fat stranding around the posterior retrobulbar structures. The optic chiasm and post chiasmatic optic tracts appear unremarkable. The inflammation and enhancement appears to be within the orbit with no extraorbital findings. The optic nerve and superior ophthalmic veins appear unremarkable bilaterally.. The right orbit is unremarkable.

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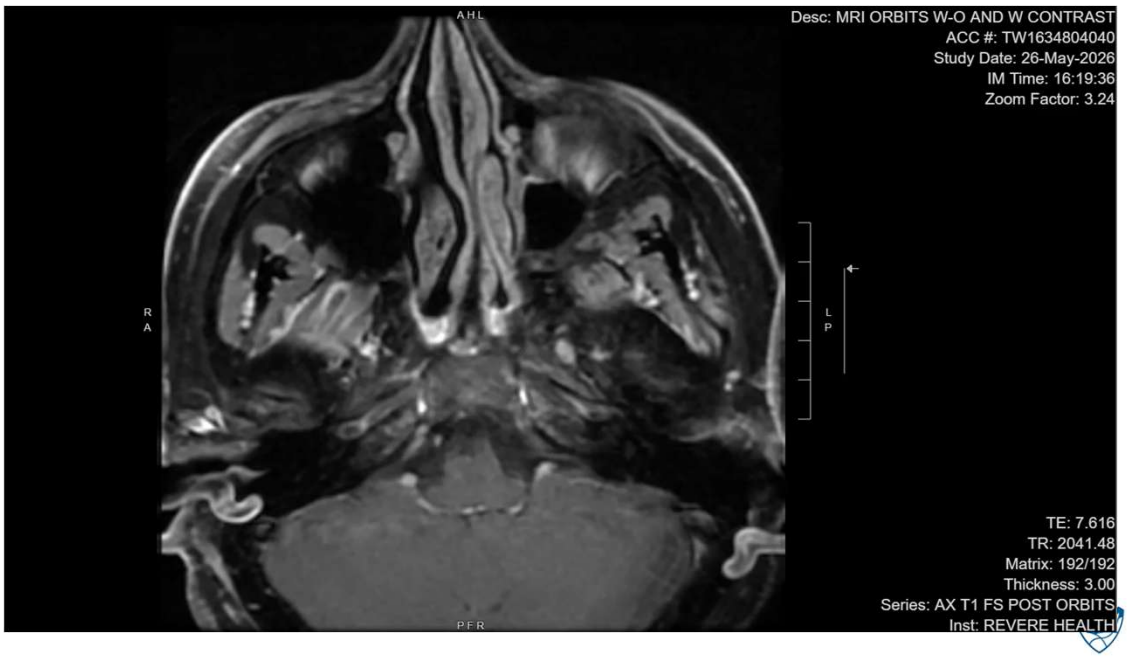
Axial (Contrast + FS)



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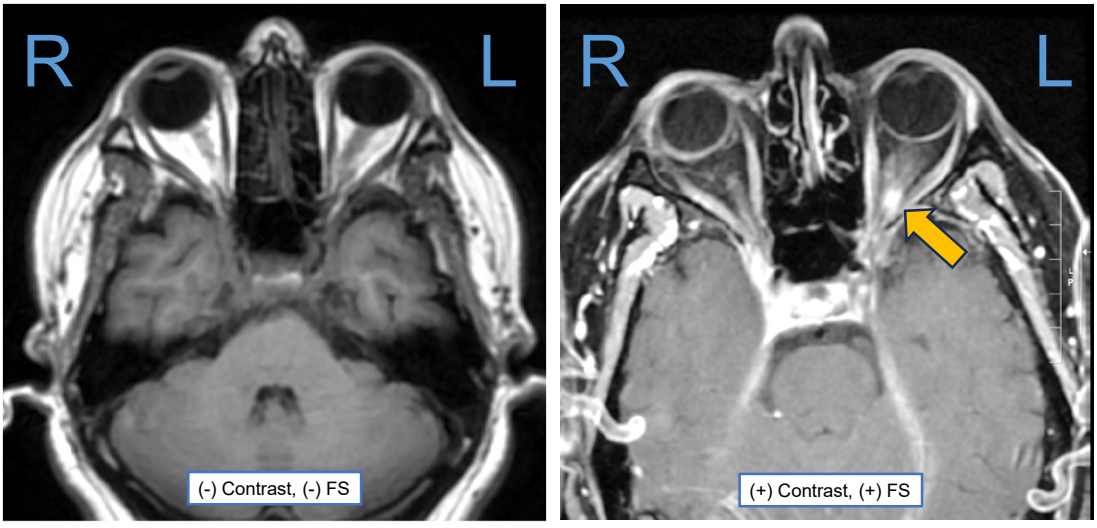
Axial T1 MRI



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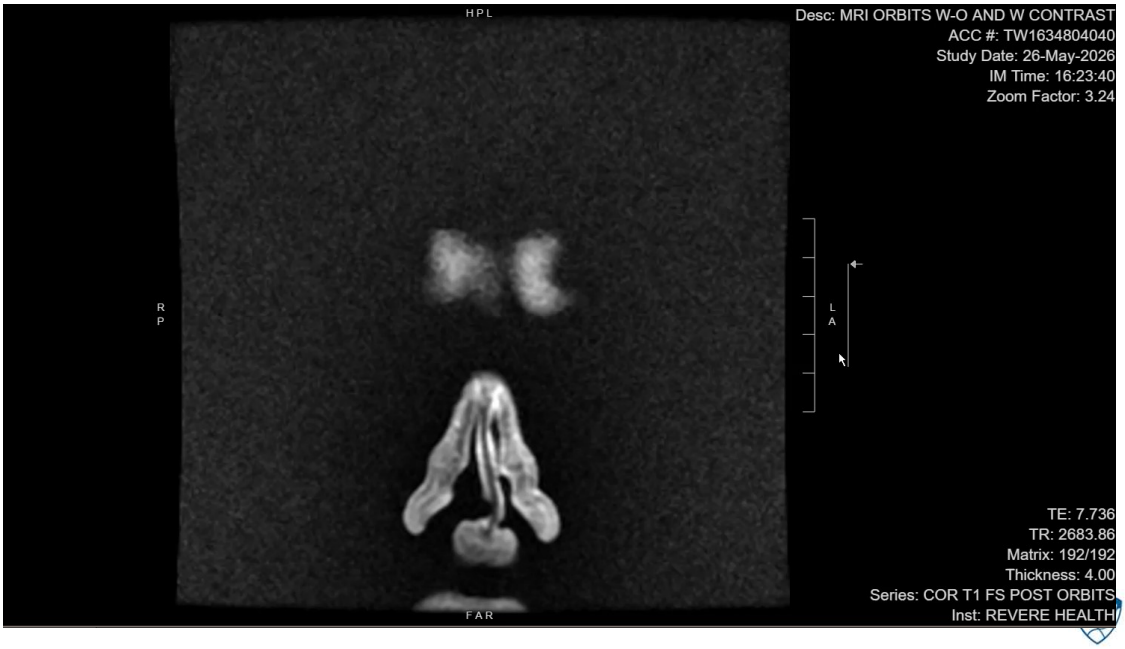
Coronal (Contrast + FS)



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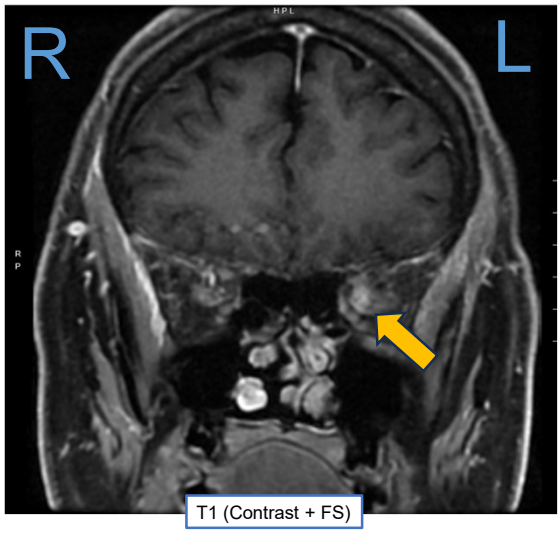
Coronal MRI



T1 (Contrast + FS)

T2 (No Contrast or FS)

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Imaging Report

IMPRESSION:
* No acute intracranial abnormality. No areas of ischemia, edema or hemorrhage.
* No brainstem or posterior fossa lesion.
* No periventricular or callosal white matter lesions.
* There is enlargement, indistinctness, and enhancement of the posterior lateral aspect of the left retrobulbar structures adjacent the posterior margin of the left optic nerve. There is enlargement and indistinctness of the left optic nerve near the orbital apex. The area of enhancement in the orbit is approximately 11 x 8 mm best seen on axial series 13 image 7 and coronal series 14 image 13. There is ill-defined retrobulbar edema and indistinct retrobulbar fat on the T1-weighted images.

* Differential diagnostic possibilities would include most likely an inflammatory process such as orbital pseudotumor. An ill-defined orbital tumor such as an orbital lymphoma or venolymphatic malformation is possible but felt less likely. The ill-defined enhancement, fat stranding, and indistinct nature of this retrobulbar enhancement and inflammation is more suggestive of pseudotumor.

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Clues + Imaging → DDx

- Clues:
  - Multiple R-sided cranial nerve palsies (3/4/6)
  - Prior hx of L-sided cranial nerve (5/7)
  - Indistinct enhancement of left orbital apex
- DDx:
  - Significant HA → Space-occupying mass?
  - R midbrain lesion?
  - ***Idiopathic orbital inflammation (Orbital pseudotumor)?***

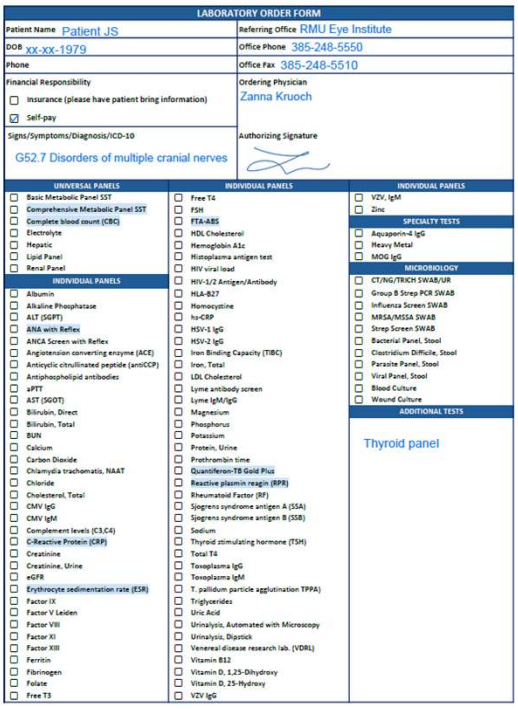
Idiopathic Orbital Inflammation is a diagnosis of exclusion.

Rule out:
- Infections
- Thyroid eye disease
- Systemic inflammatory / autoimmune diseases
- Neoplasm

90

Diagnostic Approach

- Serology:
  - CBC
  - CMP
  - Thyroid panel
  - ESR/CRP
  - ANA with reflex
  - QuantiFERON TB Gold plus
  - RPR/FTA-ABS
- Imaging:
  - Chest X-ray



LABORATORY ORDER FORM

Patient Name: Patient JS
DOB: xx-xx-1979
Phone:
Financial Responsibility
☐ Insurance (please have patient bring information)
☑ Self-pay
Signs/Symptoms/Diagnosis/ICD-10
G52.7 Disorders of multiple cranial nerves

Referring Office: RMU Eye Institute
Office Phone: 385-248-5550
Office Fax: 385-248-5510
Ordering Physician
Zanna Kruoch
Authorizing Signature

UNIVERSAL PANELS
☐ Basic Metabolic Panel SST
☐ Comprehensive Metabolic Panel SST
☐ Complete blood count (CBC)
☐ Electrolyte
☐ Hepatic
☐ Lipid Panel
☐ Renal Panel

INDIVIDUAL PANELS
☐ Albumin
☐ Alkaline Phosphatase
☐ ALT (SGPT)
☐ ANA with Reflex
☐ ANCA Screen with Reflex
☐ Angiotension converting enzyme (ACE)
☐ Anticyclic citrullinated peptide (antiCCP)
☐ Antiphospholipid antibodies
☐ aPTT
☐ AST (SGOT)
☐ Bilirubin, Direct
☐ Bilirubin, Total
☐ BUN
☐ Calcium
☐ Carbon Dioxide
☐ Chlamydia trachomatis, NAAT
☐ Chloride
☐ Cholesterol, Total
☐ CMV IgG
☐ CMV IgM
☐ Complement levels (C3,C4)
☐ C-Reactive Protein (CRP)
☐ Creatinine
☐ Creatinine, Urine
☐ eGFR
☐ Erythrocyte sedimentation rate (ESR)
☐ Factor IX
☐ Factor V Leiden
☐ Factor VIII
☐ Factor XI
☐ Factor XIII
☐ Ferritin
☐ Fibrinogen
☐ Folate
☐ Free T3

INDIVIDUAL PANELS
☐ Free T4
☐ FSH
☐ FTA-ABS
☐ HDL Cholesterol
☐ Hemoglobin A1c
☐ Histoplasma antigen test
☐ HIV viral load
☐ HIV-1/2 Antigen/Antibody
☐ HLA-B27
☐ Homocystine
☐ hs-CRP
☐ HSV-1 IgG
☐ HSV-2 IgG
☐ Iron Binding Capacity (TIBC)
☐ Iron, Total
☐ LDL Cholesterol
☐ Lyme antibody screen
☐ Lyme IgM/IgG
☐ Magnesium
☐ Phosphorus
☐ Potassium
☐ Protein, Urine
☐ Prothrombin time
☐ Quantiferon-TB Gold Plus
☐ Reactive plasmin reagin (RPR)
☐ Rheumatoid Factor (RF)
☐ Sjogrens syndrome antigen A (SSA)
☐ Sjogrens syndrome antigen B (SSB)
☐ Sodium
☐ Thyroid stimulating hormone (TSH)
☐ Total T4
☐ Toxoplasma IgG
☐ Toxoplasma IgM
☐ T. pallidum particle agglutination TPPA)
☐ Triglycerides
☐ Uric Acid
☐ Urinalysis, Automated with Microscopy
☐ Urinalysis, Dipstick
☐ Venereal disease research lab. (VDRL)
☐ Vitamin B12
☐ Vitamin D, 1,25-Dihydroxy
☐ Vitamin D, 25-Hydroxy
☐ VZV IgG

INDIVIDUAL PANELS
☐ VZV, IgM
☐ Zinc

SPECIALTY TESTS
☐ Aquaporin-4 IgG
☐ Heavy Metal
☐ MOG IgG

MICROBIOLOGY
☐ CT/NG/TRICH SWAB/UR
☐ Group B Strep PCR SWAB
☐ Influenza Screen SWAB
☐ MRSA/MSSA SWAB
☐ Strep Screen SWAB
☐ Bacterial Panel, Stool
☐ Clostridium Difficile, Stool
☐ Parasite Panel, Stool
☐ Viral Panel, Stool
☐ Blood Culture
☐ Wound Culture

ADDITIONAL TESTS
Thyroid panel

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Results

- Chronic inflammation
  - Mild normocytic anemia
  - Hyperglubulinemia
  - Elevated ESR/CRP
- Negative ANA / RPR / FTA-ABS
- Normal thyroid function
- Positive QuantiFERON-TB Gold Plus
- Negative CXR

Test	Result	Flag
QuantiFERON-TB Gold Plus	POSITIVE	Abnormal
ESR	38 mm/hr	H
CRP	1.9 mg/dL	H
Platelets	428 ×10³/µL	H
Total Protein	8.3 g/dL	H
Globulin	4.6 g/dL	H
RBC Count	4.47 x10⁶/µL	L
Hemoglobin	13.1 g/dL	L
Hematocrit	39.0%	L

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Working Dx: Occult Tuberculosis?

- CNS involvement reported ~ 80% of TB meningitis (TBM)
- Cranial neuropathies reported in 20-52% of TBM
  - Most frequent is abducens palsy followed by oculomotor palsy
  - Less common are trochlear and trigeminal nerve palsies
  - Greatest susceptibility in the subarachnoid space of the base of the brain
- Less common:
  - Gradenigo syndrome: TB involvement of petrous bone
  - Neuro-myelitis optica

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Case Conclusion

- (+) QuantiFERON Gold Plus TB resulted in referral to county health department
- (-) CXR and "normal" eye exam by OMD → No treatment
- Referred back to county health department with our records and made recommendation for additional work up including CSF studies

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Clinical Pearls

- **Leverage In-Office Testing**: Advanced neuro-ophthalmic assessments—like comitancy testing, the Parks 3-Step test, and Double Maddox Rod evaluation—allow primary care eye providers to precisely localize motility deficits and isolate cranial neuropathies directly in the exam room.
- **Integrate Diagnostic Imaging**: Neuroimaging is an essential extension of the clinical exam. Confidently order targeted protocols—such as CT for acute "B-B-B" (blood, bone trauma, foreign bodies) or thin-cut fat-suppressed MRI for orbital apex lesions—when localized signs warrant further evaluation.
- **Champion Patient Advocacy**: As primary care eye providers, optometrists must lead systemic workups for diagnoses of exclusion—ordering complete serology (e.g., ESR/CRP, QuantiFERON-TB) and coordinating multi-disciplinary care when systemic disease presents with ocular signs.

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Special Thanks

- Dr. Andrew Whyte
- Carter Madsen
- RMU Eye Institute

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Questions?

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