

FIRST YEAR AND/OR FIRST ROTATION

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I. NEURORADIOLOGY EXAMINATION

1. Prior to: [Indications & ACR appropriateness](#), Protocoling
2. During: Safety - [contrast material](#), [radiation dose](#); [Quality - adequacy of images](#)
3. Interpretation: Approach, Normal anatomy, Normal variants, & Pathology. (see below)
4. After: Reporting; Medicolegal considerations and responsibilities, including communicating results

II. TECHNIQUE, [PHYSICS](#) AND INDICATIONS

1. Understand the basic principles behind and indications for Radiological examinations-
 - a. [Radiography](#):
 - b. [CT](#) [Part 1](#), [Part 2](#)
 - i. CT window and level settings, slice thickness, inter-slice gap
 - ii. CT attenuation of normal and abnormal structures.
 - iii. Dose measures for CT, i.e. CT dose index (CTDI) values, and strategies for radiation dose reduction.
 - iv. Multiplanar Reformations and 3D reconstruction
 - c. Contrast- Types of contrast media- identify risks and manage reactions (as above)
2. [Recommended Supplement for call](#) - **CT angiography & CT venography**
CT and CTA- helical imaging parameters i.e., pitch, and image reconstruction algorithms (e.g., MPR and 3D).

III. [ANATOMY & NORMAL VARIANTS](#)

1. Brain
 - a. Cerebral lobes and surface anatomy, including identification of prominent sulci and gyri
 - b. Basal ganglia and thalamus
 - c. Brainstem and cranial nerves
 - d. Pituitary and pineal glands
 - e. Ventricles and basal cisterns
 - f. Meninges
 - g. Basic skull and skull base anatomy
 - h. Vascular – cervical and intracranial- arterial and venous
 - i. Normal variants, including vascular variants
2. Spine
 - a. Osseous components

- b. Vertebral anatomy and differences between cervical, thoracic and lumbar spine
 - c. Spinal canal and cord- intramedullary, intradural-extramedullary and extradural compartments
 - d. Normal variants
3. Head and Neck
- a. Calvarium
 - b. Anatomy of spaces of neck
 - c. Salivary glands, thyroid
 - d. Oral cavity and oropharynx, hypopharynx, laryngopharynx
 - e. Lymph node levels
 - f. Orbits- bony and ocular anatomy
 - g. Sinus anatomy – turbinate and meatal anatomy, the osteomeatal unit (OMU) and normal drainage pathways of the paranasal sinuses
 - h. Normal variants
4. Basic MR anatomy
- a. Brain
 - b. Head & Neck
 - c. Spine
 - d. Normal MRI variants
5. CT Angiography and CT Venography

IV. INTERPRETATION APPROACH (as below)

1. Radiography
2. CT
3. Brain
4. ENT
5. Spine

V. BRAIN PATHOLOGY

1. Edema- cytotoxic (CVA) versus vasogenic (tumor, inflammation, infection), osmotic and interstitial
2. Stroke-
 - a. Ischemic versus hemorrhagic
 - b. Arterial versus venous
 - c. Vascular distributions
 - d. Patterns of ischemic stroke
 - e. Early detection by CT
3. Neoplasms
 - a. Single versus multiple
 - b. Primary versus secondary
 - c. Location: intra-axial versus extra-axial, gray or white matter, supra-versus infratentorial

- d. Enhancement pattern
 - e. Pediatric versus adult
4. Trauma-
 - a. Fractures- calvarial, skull base, temporal bone
 - b. Hematomas-
 - i. Extra-axial: Epidural (arterial and venous), Subdural (different ages)
 - ii. Intra-axial: Contusions and shearing injury (grading)
 - c. Non-accidental trauma
 5. Hemorrhage
 - a. Blood Density evolution – expected evolution and variants
 - b. Type, by location – parenchymal, epidural, subdural, subarachnoid
 - c. Hemorrhagic transformation of infarcts- differentiation from contrast
 - d. Hypertensive bleeds- common sites
 - e. Differentiation of subdural from extradural blood
 - f. Hyperdense noncalcified lesions on CT
 - g. Calcified intraparenchymal lesions
 6. Hydrocephalus-
 - a. Differentiate atrophy from hydrocephalus
 - b. Distinguish intraventricular vs extraventricular obstructive
 - c. Radiographic acuity/ compensation
 - d. Shunt types
 - e. Shunt follow up- ventricle size measurements
 - f. Complications of shunts- slit ventricle, shunt dependence, trapped ventricle
 7. Brain herniation patterns
 8. Calcifications- physiologic versus pathologic, causes
 9. Postoperative findings on CT
 10. Vascular disorders –
 - a. Aneurysms, arterio venous malformations
 - b. dissection,
 - c. thrombosis (arterial and venous)
 - d. NASCET criteria

VI. SPINE PATHOLOGY

1. Trauma-
C spine

T and L Spine

- a. Stable versus unstable fractures
- b. Compression, burst and chance fractures

- c. Fracture patterns and associated injuries
- d. Spondylolysis and Spondylolisthesis
- 2. [Post-operative spine](#)- x-rays & CTs for assessment of hardware, alignment
- 3. Spinal Hemorrhage-
 - a. [Epidural](#)
 - b. [Subdural](#)
 - c. [Subarachnoid](#)

VII. HEAD AND NECK

- 1. [Maxillofacial, mandibular and orbital trauma](#)- fracture classifications
- 2. [Sinusitis](#)- acute and chronic Sinus ([sinus opacification Ddx](#))
- 3. [Neck Infections and abscesses](#)- Airway compromise
- 4. [Foreign bodies](#)
- 5. [Thyroid lesions](#): Dx and management
- 6. [Abnormal lymph nodes](#): Dx and management
- 7. [Vascular anomalies](#) – vascular compromise, including atherosclerosis, stenosis, clot and occlusion

SECOND YEAR/ROTATION –

Review all materials from 1st rotation plus:

I. TECHNIQUE AND INDICATIONS

1. Understand the basic principles behind and indications for use of methods of [MR](#) examinations
 - a. Brain: T1, T2, FLAIR, DWI, SWI, 3D GRE, 3D, post-contrast, fat suppression
 - b. Vascular: TOF MRA, post-contrast MRA, TOF MRV, post-contrast MRV, fat suppression techniques
 - c. ENT: IR, fat sat post-contrast
 - d. Spine: T1, T2, STIR, GRE, 3D, fat sat post-contrast
2. Types of [contrast media](#)- identify risks and manage reactions
3. [Lumbar Punctures](#): fluoro-guided LP, myelogram (C/T/L), cisternogram- indications, techniques and perform

II. [ANATOMY](#):

1. Brainstem, cranial nerves, white matter tracts
2. Spine vascular structures
3. Orbits and sinuses
4. Temporal bone
5. Skull base
6. Head and neck- spaces of neck, lymph node levels

III. BRAIN PATHOLOGY- CT and MRI Correlation:

1. Differential diagnosis by location
2. Stroke- Role of CTA, [CTP](#), [MRI](#), [MRA](#), [MRP](#), [Evolution of stroke](#), TIA, vascular occlusion and atherosclerosis
3. Tumor-
 - a. [WHO Grading and imaging correlates](#)
 - b. [Gliomatosis](#)
 - c. [Tumor mimics](#)- subacute infarcts, subacute hematomas, demyelinating lesions
 - d. [Ring enhancing masses](#)
 - e. [Intraventricular masses](#)
 - f. [Tumors crossing corpus callosum](#)
 - g. [Cerebellopontine angle tumors and mimics](#)
 - h. [Cortical based tumors](#)
 - i. [Fat containing masses](#)
 - j. [Calcified/hemorrhagic masses](#)
 - k. [MR diffusion and MR Perfusion](#)
 - l. [Pineal](#) and [pituitary](#) tumors
 - m. [Nontumoral cysts](#)- Arachnoid, Colloid, Dermoid/Epidermoid, Enlarged VR spaces, Porencephalic cysts
4. Trauma-
 - a. [Skull base](#) and [temporal bone fractures](#)

- b. [Evolution of hematomas based on location- Parenchymal vs. SAH vs. SDH/EDH](#)
 - c. [Sequelae of brain herniation](#)
 - d. [Chronic findings after trauma](#)
 - e. [Criteria of brain death](#)
 - f. [Chronic traumatic encephalopathy](#)
 - g. [Traumatic intracranial and extracranial dissections](#)
 - h. [Traumatic carotid cavernous fistula](#)
5. Hemorrhage –
- a. [Determining age of hemorrhage on MRI](#)
 - b. Patterns of bleeds- [hypertensive](#), [amyloid angiopathy](#)
 - c. [When to suspect underlying lesion](#)
 - d. [Primary tumors known to hemorrhage](#)
 - e. [Hemorrhagic metastases to brain](#)
 - f. [Hemorrhagic transformation of infarcts](#)
 - g. [Venous infarcts](#)
 - h. [Embolic- septic emboli and mycotic aneurysms, fat emboli](#)
 - i. [Nontraumatic, nonaneurysmal subarachnoid hemorrhage](#)
6. [CNS infections-](#)
- a. [Parenchymal versus extra-axial](#)
 - b. Typical ([pyogenic abscess](#)) versus atypical (Herpes, Neurocysticercosis, Lyme)
 - c. [Infections in Immunocompromised \(HIV/ AIDS\)](#)
 - d. Chronic granulomatous infections ([Tuberculosis](#), [fungal](#))
 - e. Noninfectious inflammatory conditions (including [sarcoidosis](#))
7. [Demyelinating diseases- primary- types of MS, criteria, role of imaging, ischemic, infection](#)
8. CSF dynamics-
- a. [Intracranial hypo-and hypertension](#)
 - b. [CSF leaks](#)
 - c. [CSF diversion procedures](#)
 - d. [Normal Pressure Hydrocephalus](#)
9. Vascular-
- a. Basics of [CTA, MRA](#) and [DSA](#)
 - b. [Aneurysms](#)
 - c. [Arterial and venous variants](#)
 - d. [Arteriovenous malformations \(basics\)](#)
 - e. [Carotid stenosis](#)
 - f. [Dissection](#)
10. [Epilepsy-](#) Temporal Lobe anatomy, Mesial Temporal Sclerosis

IV. SPINE PATHOLOGY

- 1. Degenerative spine disorders, including [lexicon](#)
 - a. Types of disorders –
 - i. [Diffuse idiopathic skeletal hyperostosis](#)
 - ii. [Disc herniation](#)

- iii. [Disc-osteophyte](#)
 - iv. [Juxta-articular cysts](#)
 - v. [Ossification of the posterior longitudinal ligament](#)
 - vi. [Spinal stenosis](#)
 - vii. [Spondylolisthesis and spondylolysis](#)
 - b. [Disc morphology – bulge, protrusion, extrusion, sequestration](#)
 - c. [Lumbar Disc pathology location – central, subarticular, foraminal, far lateral, anterior](#)
- 2. [Trauma](#)-
 - a. MRI- criteria of instability
 - b. Ligamentous injuries
 - c. Cord injury
 - d. Epidural, subdural and subarachnoid hemorrhages
 - e. Craniovertebral fractures- Atlanto-occipital dislocation, C1/C2 fractures
- 3. [Spine infections](#) and inflammations
 - a. Discitis Osteomyelitis
 - b. Spinal Abscess
 - c. [Nonpyogenic infections](#)
 - d. [Acute](#) and [chronic](#) inflammatory polyneuropathies
 - e. Demyelination- [Multiple sclerosis](#) and [ADEM](#)
 - f. [Transverse Myelitis](#)
- 4. [Tumors](#)-
 - a. Extradural
 - b. Intradural extramedullary
 - c. Intramedullary
- 5. [Post-operative](#)- CT and MRI for hardware, acute bleeds. Recognizing acute postsurgical complications including acute epidural and hardware associated hemorrhage; misplaced or incorrectly placed hardware. Chronic hardware failure including features of hardware loosening and fractures. Metal artifact reduction techniques for [CT](#) and [MRI](#).

V. HEAD AND NECK PATHOLOGY

- 1. Sinus and osteomeatal unit (OMU) disease- [infection, inflammation, tumors](#)
- 2. [Facial and orbital trauma- fracture associations and complications](#)
- 3. [Skull base](#) and [temporal bone](#) basics
- 4. Neck- [lymphadenopathy, infections, tumor classification based on location](#)

THIRD YEAR/ROTATION

Review material for R1 and R2

- I. TECHNIQUE AND INDICATIONS** - Understand the basic principles behind and indications for use of methods of examination-
1. CT- CTA, CTV, CT Perfusion- [Dual energy CT](#)
 2. MRI – Basics of advanced imaging techniques
 - a. [Diffusion tensor imaging](#) (principles of DTI)
 - b. [Functional MRI](#) (principles of BOLD)
 - c. [MR artifacts](#)
 - d. MR perfusion (use in [neoplasms](#) and [stroke](#))
 - e. [MR spectroscopy](#) (NAA, Choline, lactate)
 - f. [Susceptibility weighted imaging](#)
 3. [Myelography](#)
 4. [Cisternography](#)
 5. [Digital Subtraction Angiography- Observe, indications, anatomy](#)
 6. Be able to choose appropriate examination types for a variety of clinical situations and recognize strengths and weakness of each type of imaging exam- ACR Appropriateness Criteria® (<http://www.acr.org/Quality-Safety/Appropriateness-Criteria>)

II. ANATOMY

1. White matter- [normal myelination](#)

III. BRAIN PATHOLOGY

1. Stroke –
 - a. [Hypoxic ischemic encephalopathy](#) (HIE)-Preterm, Term and Adults
 - b. [Vasculitis](#)
 - c. [Posterior reversible encephalopathy syndrome \(PRES\)](#)
 - d. [Risks and benefits of and imaging after thrombolysis/ neurointerventional procedures](#)
2. Tumor- MR Perfusion techniques, MR spectroscopy, [RANO Criteria](#)
3. [Hemorrhage](#)- underlying lesions, active bleeds
4. [Vascular](#)- atherosclerosis, vasculopathies, venous thrombosis, arteriovenous malformations, vascular injuries
5. [CNS infections](#)-
 - a. Congenital Infections-CMV, Toxoplasmosis
 - b. Fungal and less common infections
 - c. Sequelae of infections
 - d. AIDS and complications
 - e. Routes of spread of non CNS infections to brain
6. White matter-
 - a. [Inherited metabolic disorders \(limited\)](#)
 - b. [Demyelinating and dysmyelinating diseases- toxic and metabolic](#)

7. Neurodegenerative- Alzheimer's, metabolic, infectious (Prion disease): [Part 1](#), [part 2](#)
8. Cranial Nerve Pathologies part [1](#), [2](#), [3,4,5](#)- Schwannomas, leptomeningeal carcinomatosis, perineural spread, infection (Lyme), inflammation (Sarcoid)
9. Congenital/developmental-
 - a. Brain malformations- [Chiari 1](#) and [2](#), [Holoprosencephaly](#), [Dandy Walker spectrum](#)
 - b. [Corpus callosum anomalies-agenesis/dysgenesis](#)
 - c. Sulcation and migrational anomalies
 - d. [Phakomatoses](#)- NF1, NF2, Tuberous sclerosis, Sturge Weber and von Hippel Lindau
10. [Epilepsy](#)- malformations of cortical development
 - a. Hemimegalencephaly
 - b. Heterotopia
 - c. Polymicrogyria, Lissencephaly and schizencephaly
 - d. Focal cortical dysplasia
11. [Toxic/Metabolic](#)- Alcoholic, Wilson's, Hepatic encephalopathy, Osmotic demyelination, Chemotherapy, drug abuse

IV. SPINE PATHOLOGY

1. [Congenital](#)-
 - a. Neural tube defects-Myelomeningocele, Lipomyelomeningocele, Lipomas, Dermoid, Caudal Regression, Sacrococcygeal Teratoma
 - b. Segmentation anomalies
 - c. Phacomatoses -NF1, NF2
 - d. Congenital/Metabolic/Connective tissue-- Osteogenesis Imperfecta, Marfan's, Osteopetrosis,
 - e. Craniovertebral junction variants-Platybasia, Basilar invagination
2. [Spine vascular](#)- infarcts, vascular malformations
3. Miscellaneous- [arachnoid cysts](#), [cord herniation](#), [DISH](#), [OPLL](#), [Longus coli tendonitis](#)
4. Spinal manifestations of systemic diseases/Arthritis -[Sickle cell](#), [renal/dialysis](#), [Gout/ CPPD](#), [seronegative spondyloarthropathy](#), [rheumatoid arthritis](#)
5. [Post procedural imaging and complications](#)- MRI findings- hemorrhage, soft tissue injury, arachnoiditis
6. Nerve plexus- [Brachial](#) and [Lumbosacral](#)-anatomy and pathology

V. HEAD AND NECK PATHOLOGY

1. [Sinonasal tumors](#)- nodal and [perineural spread](#)
2. [Orbital tumors](#)- Retinoblastoma, Lymphoma, optic glioma, meningioma
3. [Orbital Infections and Inflammation](#)-Preseptal versus post septal, endophthalmitis, optic neuritis, psuedotumor, PHPV, retinopathy of prematurity, thyroid orbitopathy
4. [Congenital skull base variants and pathologies](#)- nasal masses, meningioma, fibrous dysplasia, chordoma, cartilaginous tumors
5. [Pharyngeal](#) and [laryngeal](#) tumors-benign and malignant

6. Mandible/maxilla –[cysts](#), [infections](#), [tumors](#), [fractures](#)
7. Salivary gland - [infections](#) and [tumors](#)
8. Temporal bone pathology
 - a. [Cholesteatoma](#) and [cholesterol granuloma](#)
 - b. [Facial nerve & internal auditory canal enhancement differential diagnosis](#)
 - c. [Fractures](#)
 - d. [Glomus tumors](#)
 - e. Vascular anomalies – [Aberrant carotid artery](#), [vascular dehiscence](#)
 - f. [EAC atresia](#)
 - g. [Otitis Externa](#)
 - h. [Coalescent Mastoiditis](#)
 - i. [SCCD](#) and [EVAS/LESA](#)
 - j. [Otospongiosis](#)
9. Neck- [pediatric](#) cysts and tumors, venolymphatic malformations
10. [Postsurgical/ Post treatment Neck](#)
11. [Calvarial Lesions](#)- Craniosynostoses, Fibrous dysplasia, Paget's, Histiocytosis