

NEUROIMAGING OF INFECTIOUS DISEASE

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**ASN 42ND ANNUAL MEETING
JANUARY 24-26, 2019**



PUERTO RICO 

DISCLOSURES

NONE

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PUERTO RICO 

- **Meningitis, Encephalitis and Ventriculitis**
- **Cerebritis and Brain Abscess**
- **Orbital, Sinus, Mastoid, Dental Infections**
- **Indolent and Atypical Infections**

MENINGITIS

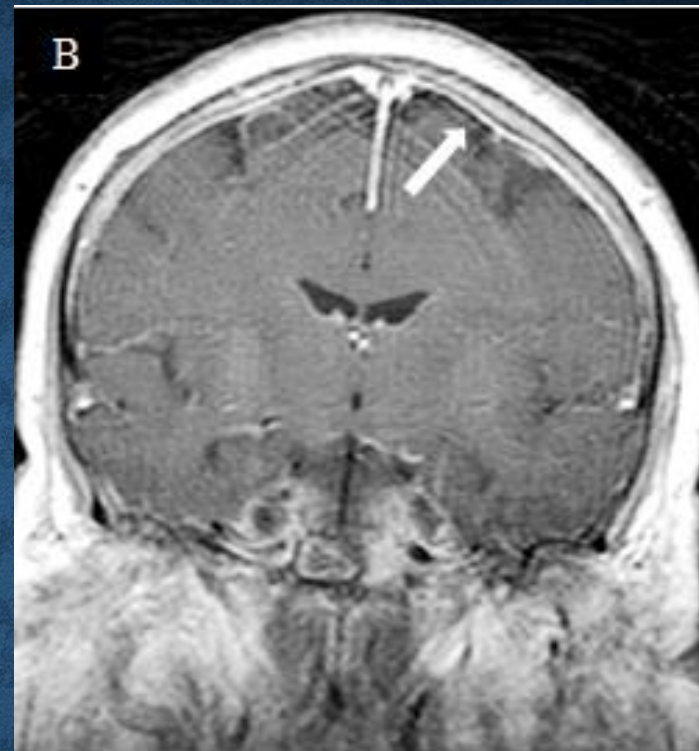
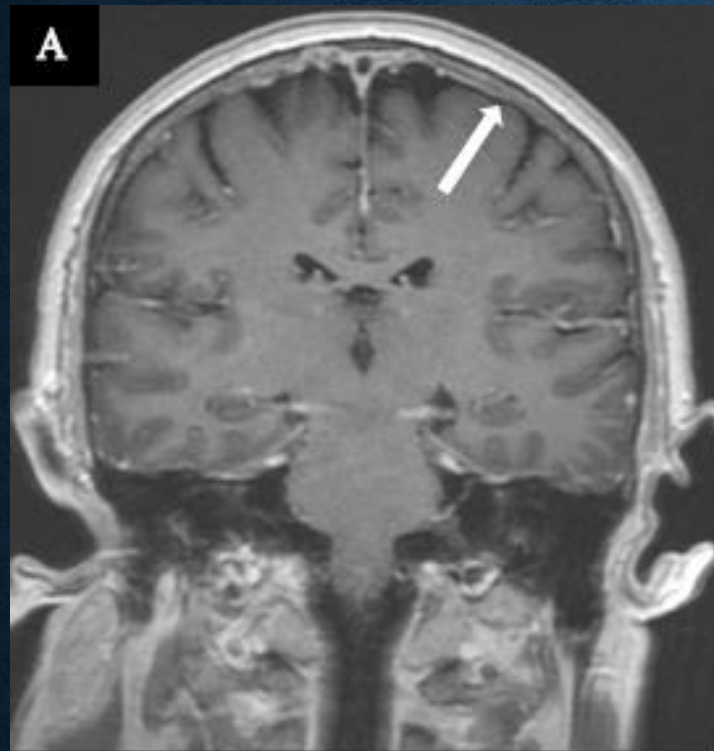
- **Meningitis is the most frequent infection of the central nervous system.**
- **Cardinal features:**
- **Fever, headache, meningismus, altered sensorium.**
- **Most cases demonstrate no specific imaging abnormalities.**
- **Imaging is indicated to exclude space-occupying lesions, hydrocephalus, and to evaluate the potential sources of infection and demonstrate other etiologies that might necessitate intervention beyond medical therapy.**

MENINGITIS

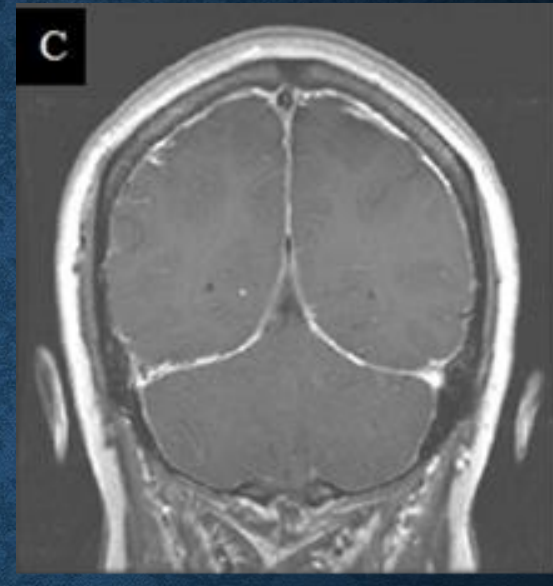
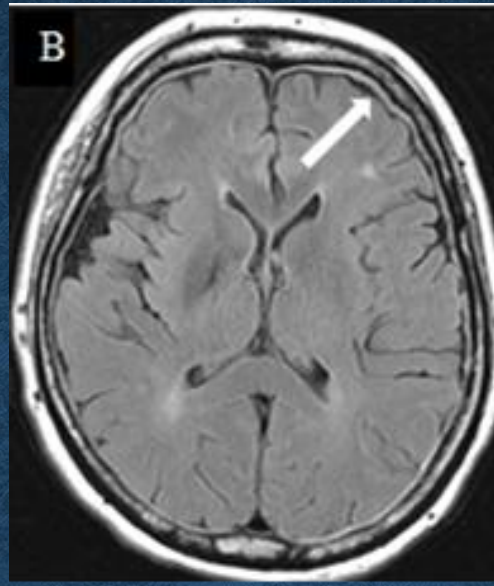
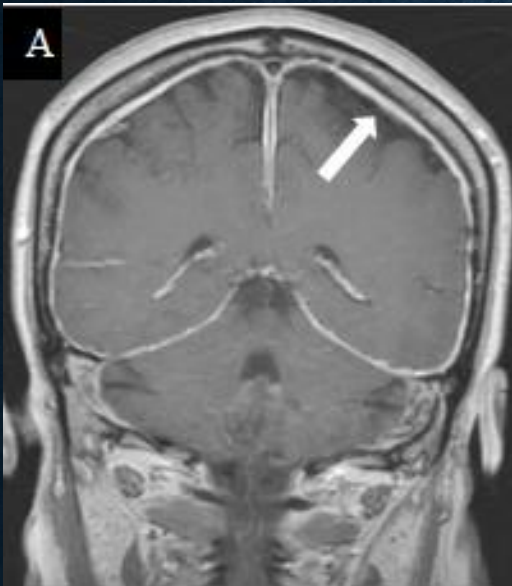
- **Viral etiologies are the most common, the majority being enteroviruses, less likely herpes viruses, arboviruses, and HIV.**
- **Less commonly lymphocytic choriomeningitis(LCM) virus, mumps, and polio (in 3rd world regions).**
- **Enteroviruses make up 85 % of cases.**
- **Arboviruses –St Louis encephalitis virus, West Nile Virus, eastern and western equine viruses, Zika, etc.**

MENINGITIS

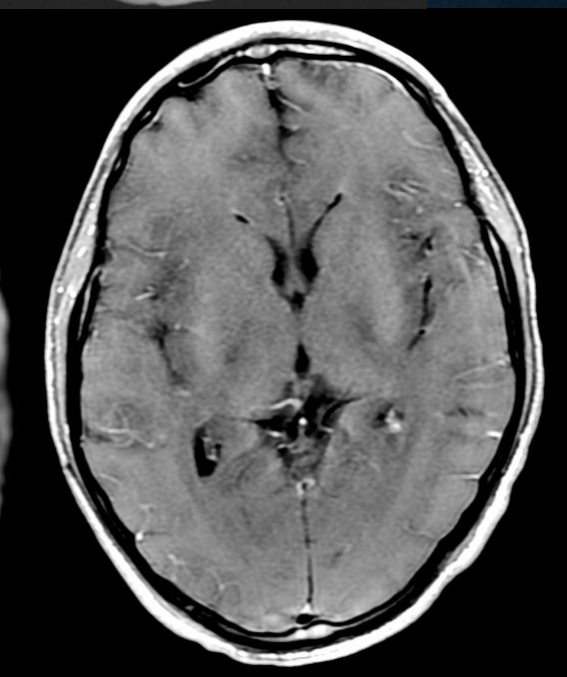
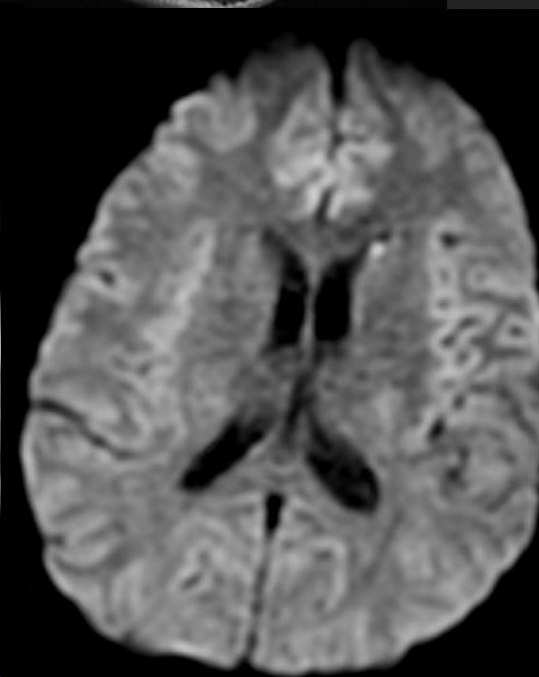
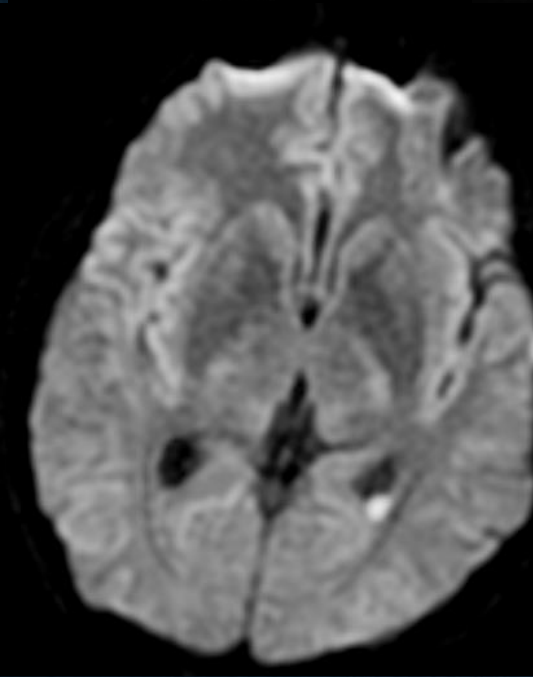
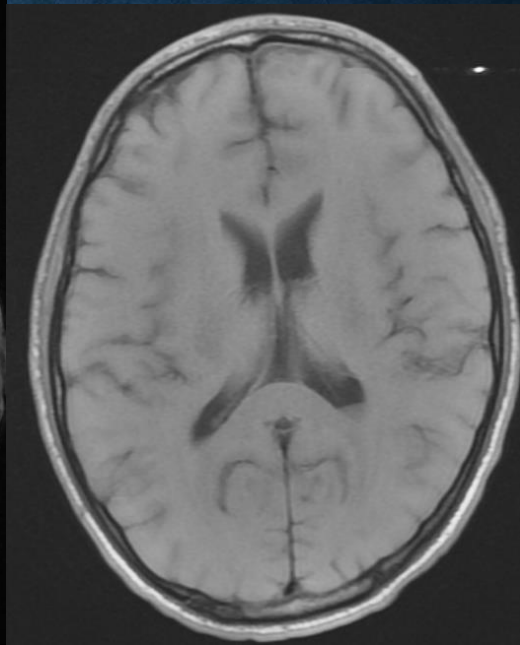
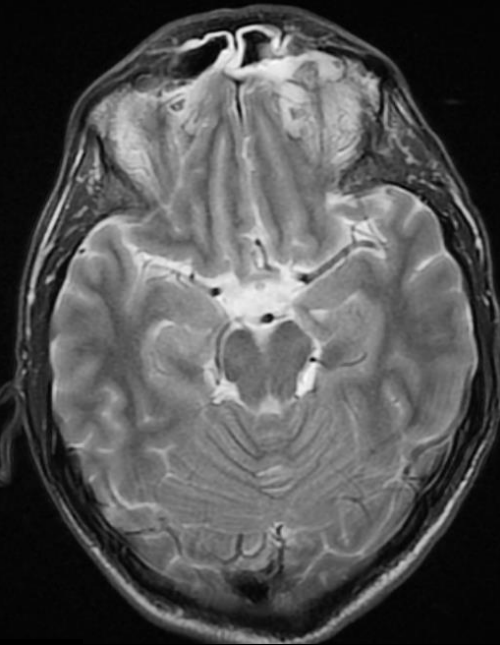
- **The most common bacterial organisms are Streptococcal pneumoniae, Neisseria meningitidis, Listeria monocytogenes, group B streptococci, and Hemophilus influenzae.**
- **Escherichia coli and group B streptococci-neonates**
- **Streptococcal pneumoniae-adults**
- **Immunocompromised-E coli, Klebsiella, Pseudomonas and fungal infections.**



A and B are T1 postcontrast coronal views of two patients both with acute pneumococcal meningitis. The arrows in A and B are pointing to the meninges. Figure A is a normal pattern of light and discontinuous contrast enhancement of the meninges and cortical vessels. Figure B is abnormal prominent and contiguous meningeal contrast enhancement.

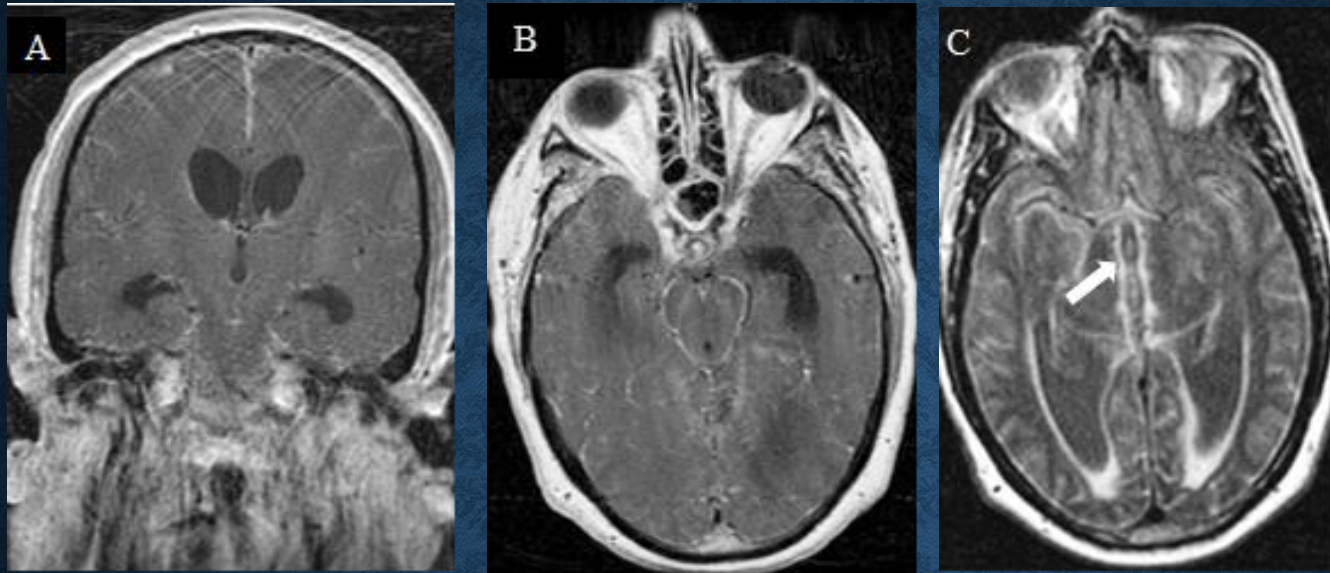


A and B is of the same patient with recurrent bacterial meningitis. There is thickening of the pachymeninges demonstrated on the coronal postcontrast T1-weighted view along with thickened and increased signal on the FLAIR-weighted view in Figure 2B. C is a post contrast T1 view of a patient with intracranial hypotension with no infectious process.



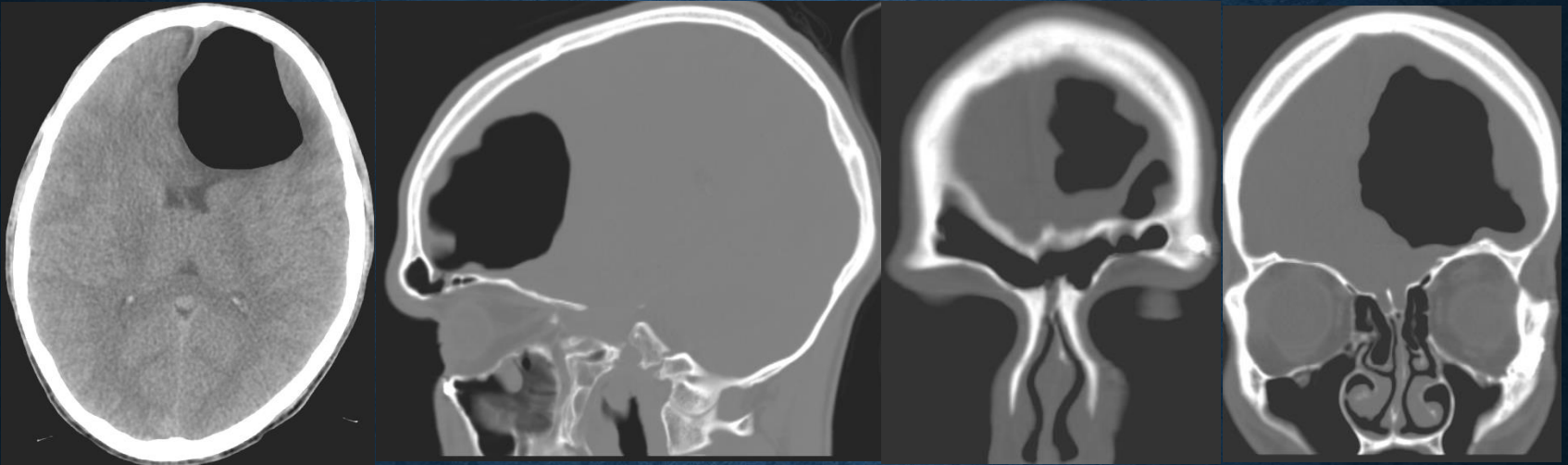
MENINGITIS

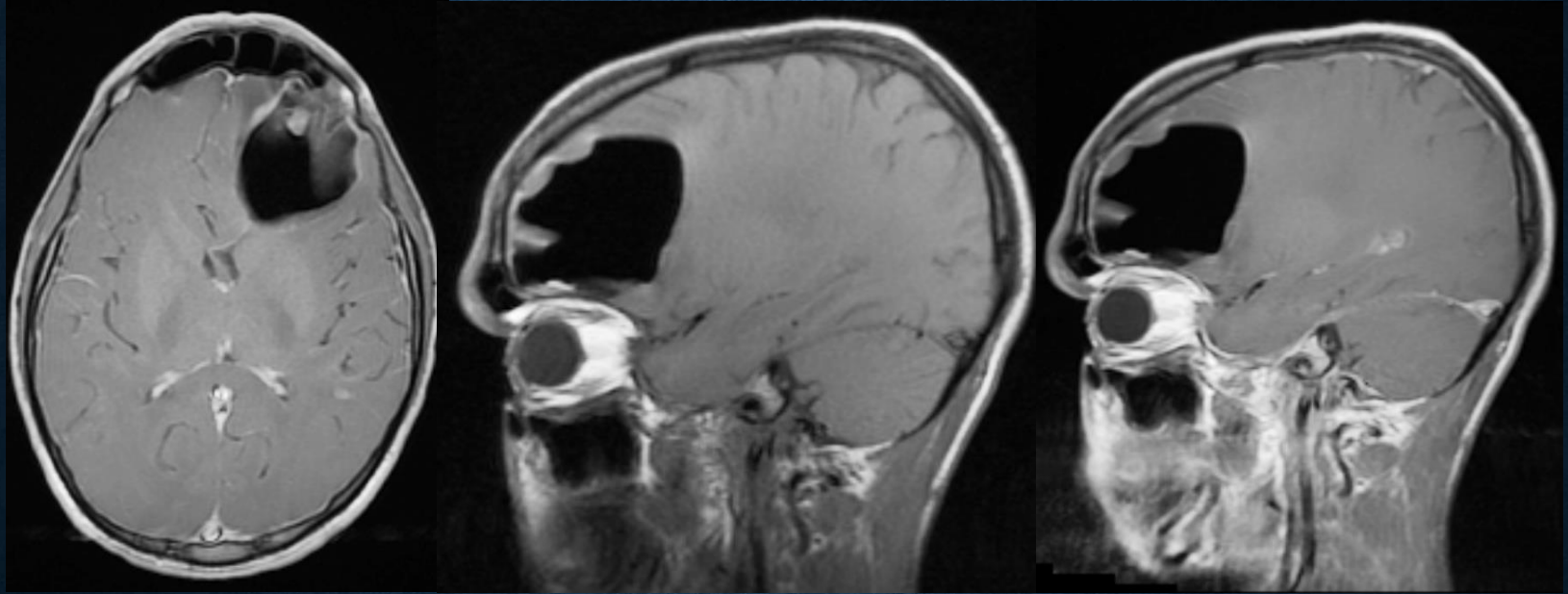
- **Other imaging features of meningitis beyond dural enhancement may include:**
- **cerebral edema with decreased conspicuousness of the cortical sulci, fissures and cisterns**
- **hydrocephalus,**
- **pneumocephalus,**
- **ventriculitis**
- **ischemic lesions/vasculitis**



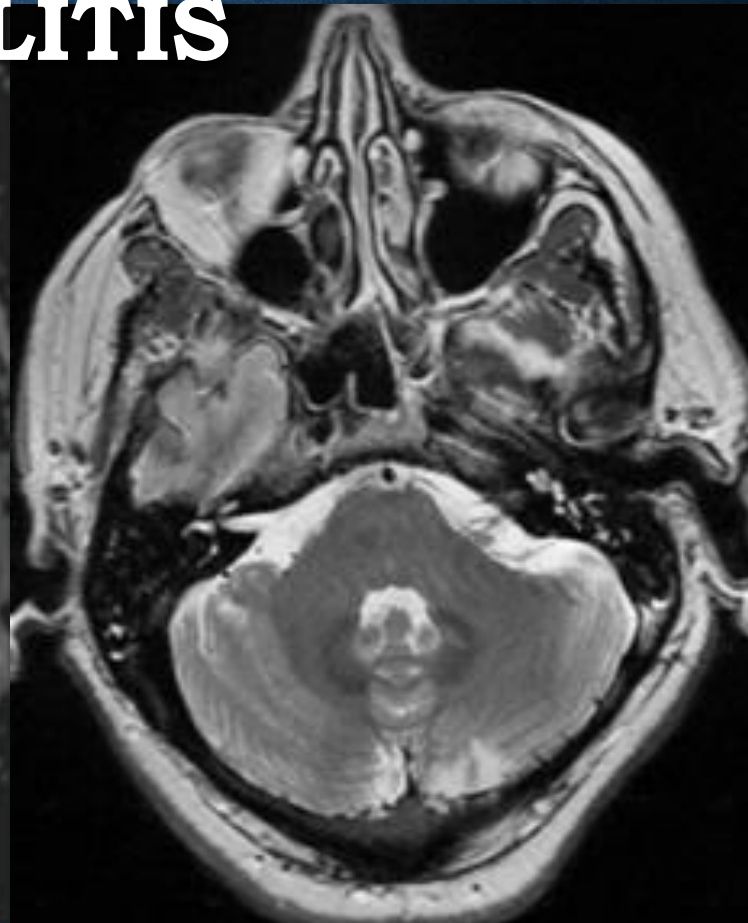
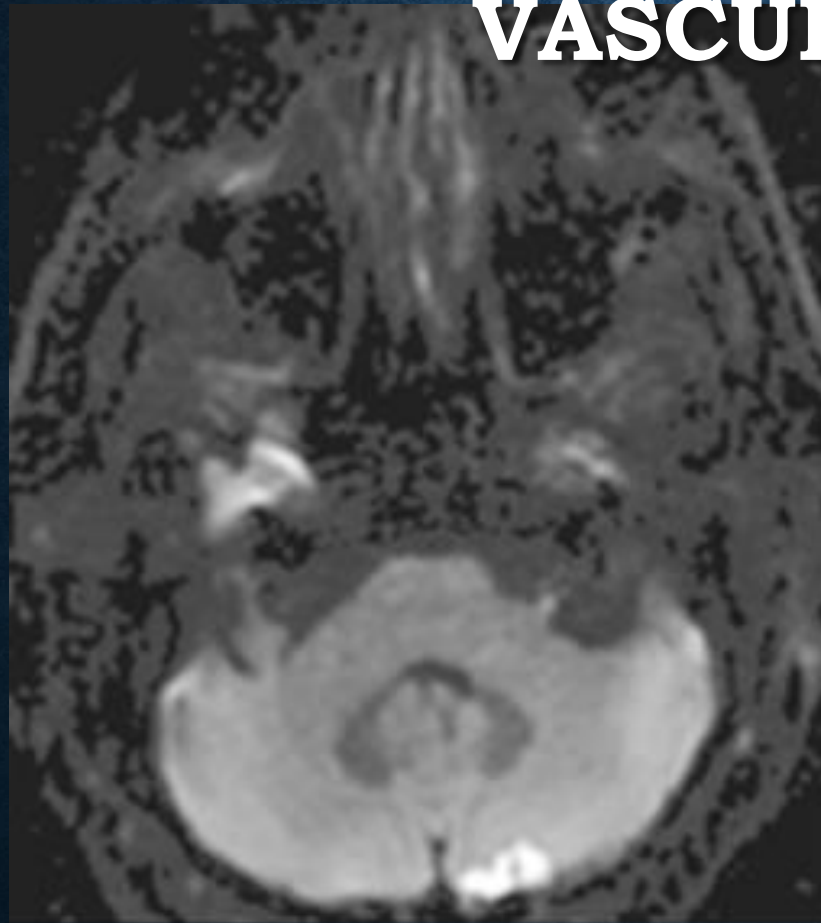
Listeria meningitis and ventriculitis. A and B are postcontrast T1-weighted views which demonstrate the moderate to severe hydrocephalus and meningeal enhancement. C is a FLAIR-weighted view demonstrating marked inflammatory changes within the lateral and third ventricle with the arrow pointing to the ependymal margin of the third ventricle with associated increased signal.

PNEUMOCEPHALUS





VASCULITIS



ENCEPHALITIS

- **HERPES SIMPLEX**-most common
- **VARICELLA ZOSTER**-vasculopathy
- **CYTOMEGALOVIRUS**- ventriculitis, myelitis, radiculitis
- **Arboviruses**-West Nile, St. Louis, Eastern and Western Equine, Zika
- **HIV, Mumps**
- **JC virus-PML**

ENCEPHALITIS (NON-VIRAL)

- **Treponema pallidum**
- **Rocky mountain spotted fever**
- **Listeria monocytogenes**
- **Mycoplasma pneumoniae**

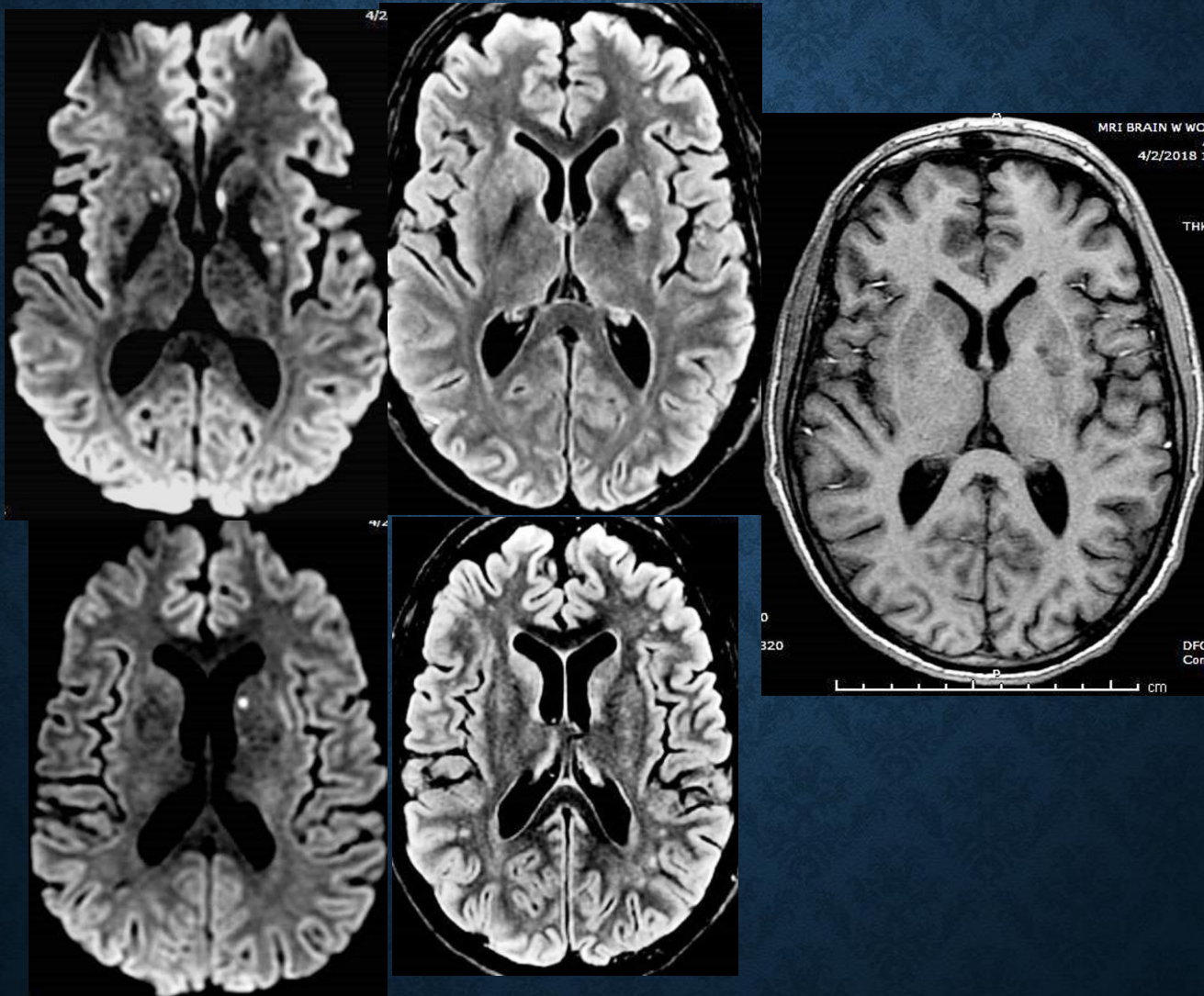
ACUTE ENCEPHALITIS

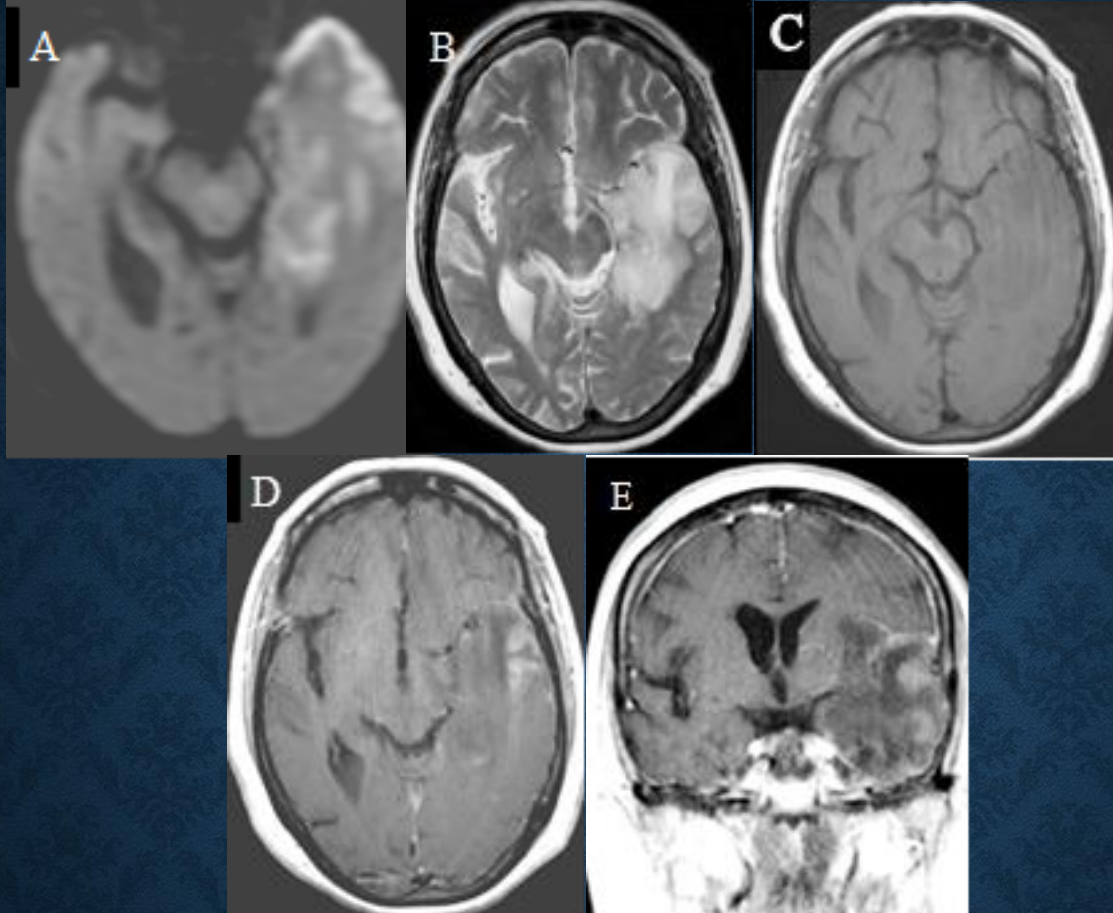
- **Herpes simplex encephalitis (HSV) most common lethal form in the USA and treatable.**
- **Most are HSV-1 with a minority predominately in neonates HSV-2.**
- **Imaging findings typically involve the temporal and ventral frontal lobes, at times bilaterally and occasional insular and cingulate.**
- **Varicella zoster virus (VZV) presents as a meningoencephalitis often with a vasculopathy and large and small vessel infarctions, vascular dissections, aneurysms and intracranial hemorrhage**

CNS CRYPTOCOCCOSIS

- *Cryptococcus neoformans*-yeast like fungus
- Most common fungal infection of CNS
- Immunocompromised and/or bird exposure
- gelatinous pseudocysts along Virchow –Robin spaces, basal ganglia and may markedly enlarge
- Cryptococcoma small or large may or may not enhance
- Variable appearance on diffusion, no edema
- Leptomeningeal and intraventricular spread and or may not enhance
- Hydrocephalus and intracranial hypertension

CRYPTOCOCCAL ENCEPHALOMENINGITIS





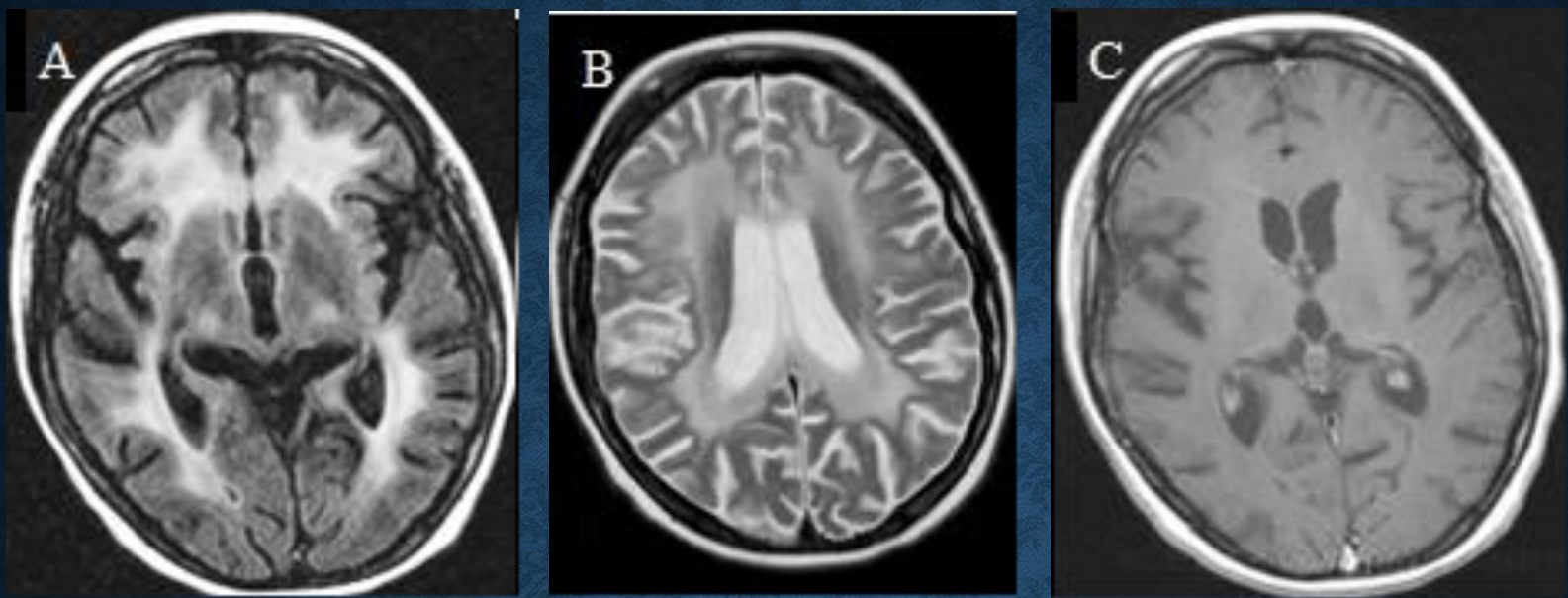
Acute herpes simplex encephalitis. A is a DWI with increased signal along the cortical ribbon of the left medial anterior temporal lobe. B is a T2-weighted view with increased signal in the region of the acute encephalitis with edema. C is a noncontrast T1-weighted view with a region of decreased signal which shows in D and C enhancement along the cortical ribbon encircling the necrotizing encephalitis.

ENCEPHALITIS-INDOLENT

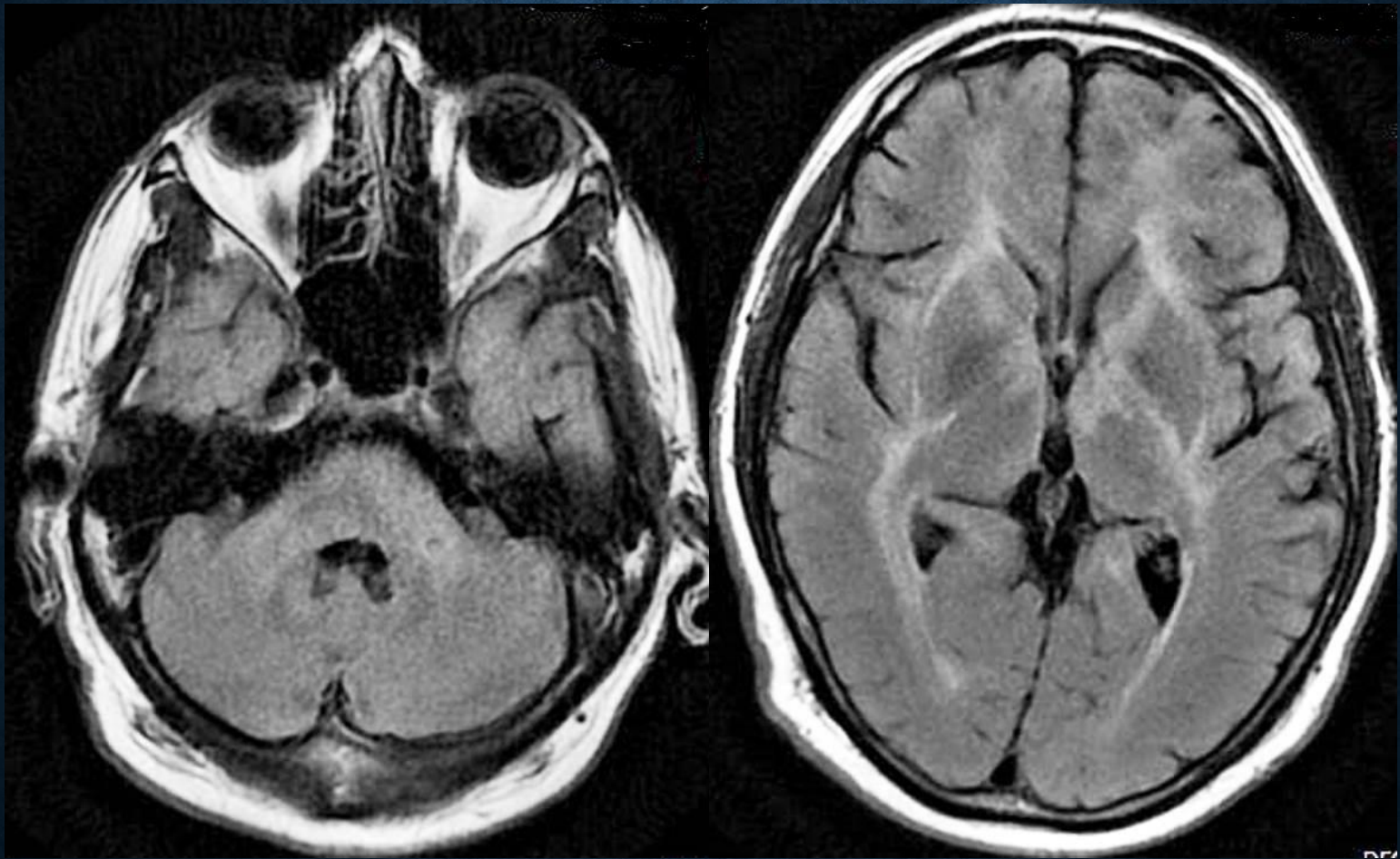
- **HIV**
- **Progressive multifocal leukoencephalopathy (PML)-
JC virus**
- **Creutzfeldt - Jakob disease (CJD)-Prion protein**
- **Syphilis-Treponema pallidum**

HIV ENCEPHALITIS

- **HIV is neurotropic virus that produces indolent or latent encephalitis.**
- **Untreated can result in HIV encephalopathy or AIDS dementia complex which on imaging demonstrates cerebral atrophy with diffuse leukoencephalopathy and hydrocephalus ex vacuo.**
- **The leukoencephalopathy is believed to be due to axonal degeneration. This is at times partially reversible.**

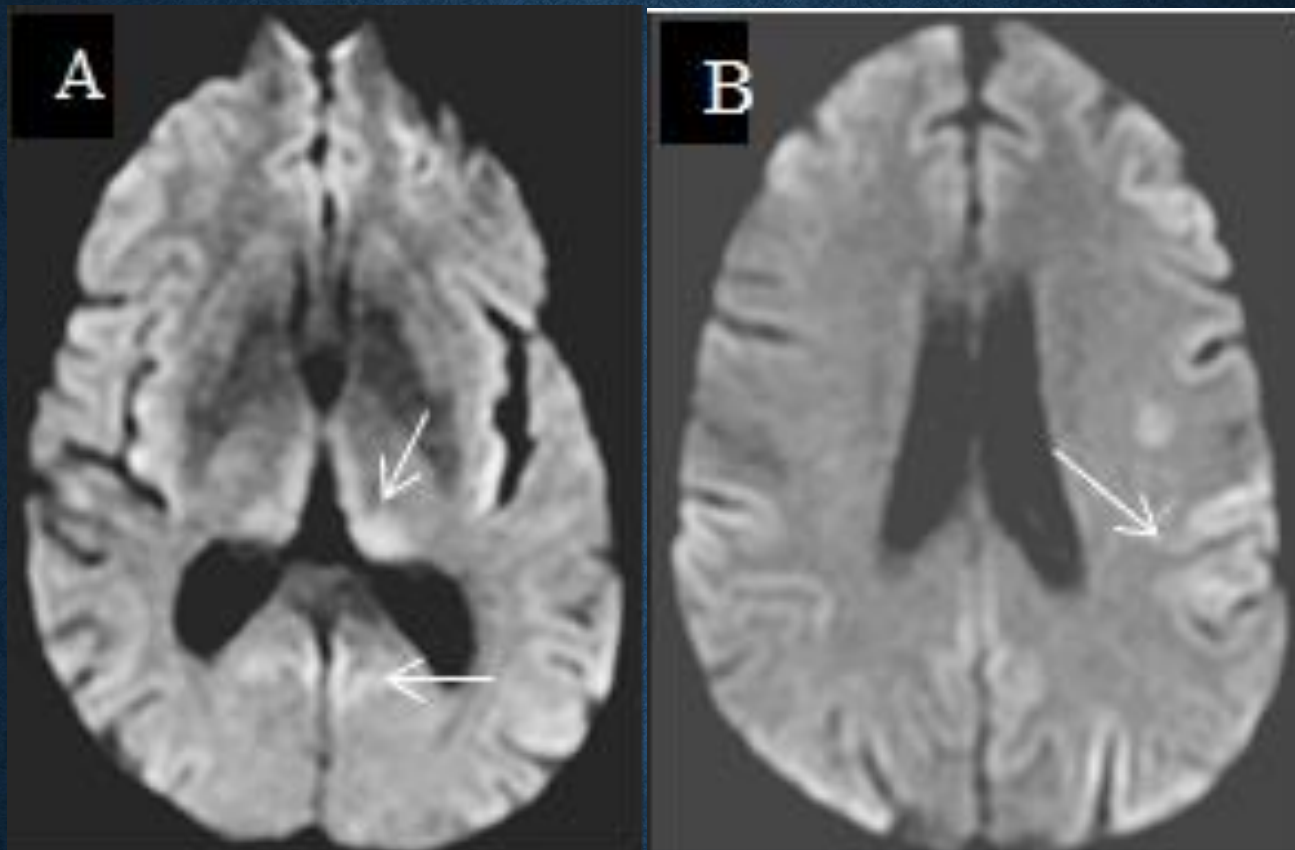


FLAIR, T2 and T1-weighted view, postcontrast, respectively, of a 23-year-old woman who presented with dementia. These views demonstrate severe cortical and subcortical volume loss along with severe diffuse white matter disease as a result of the untreated HIV virus.



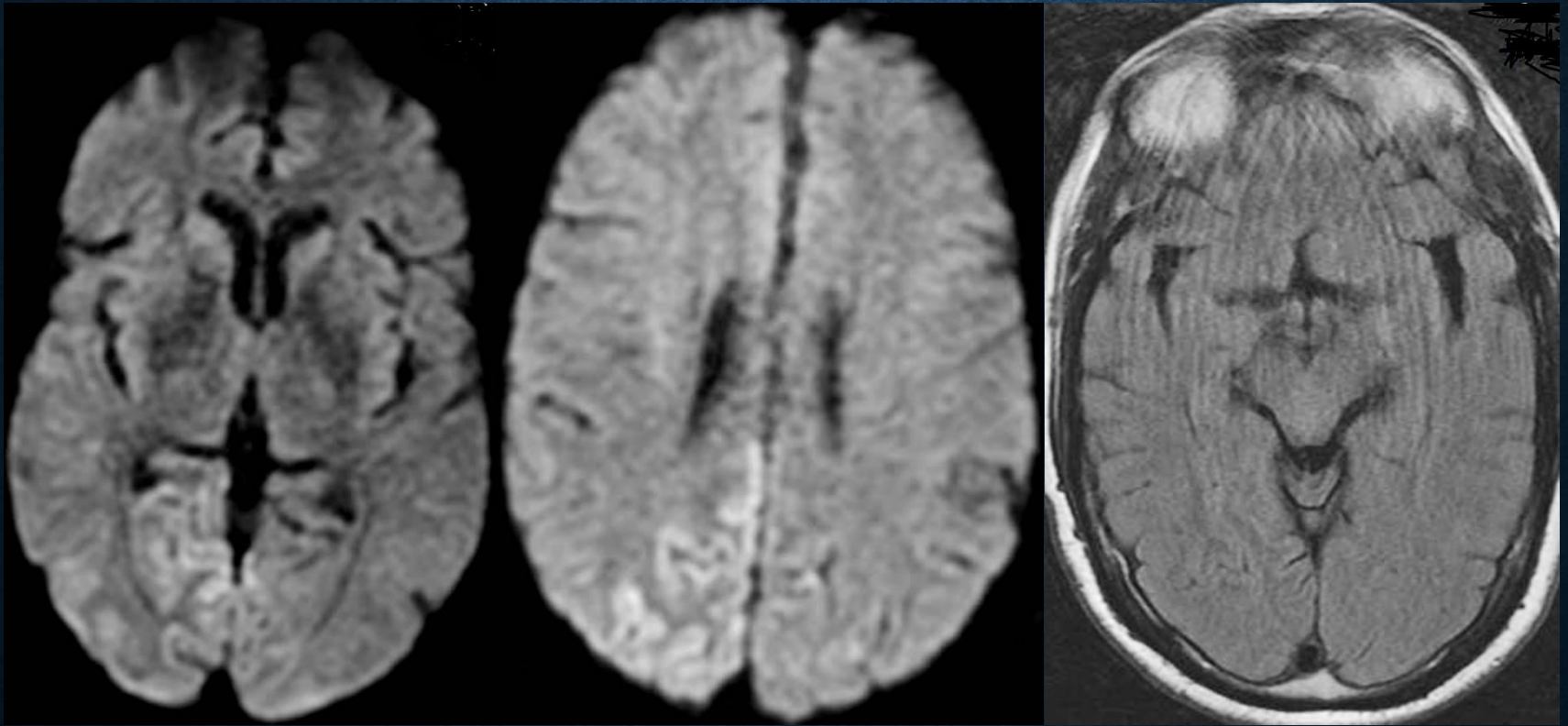
CREUTZFELDT -JAKOB DISEASE

- **Creutzfeldt - Jakob disease (CJD) is a spongiform encephalopathy and prion disease. It is a disorder which is best identified by MRI evaluation and in the proper clinical setting is pathognomonic.**

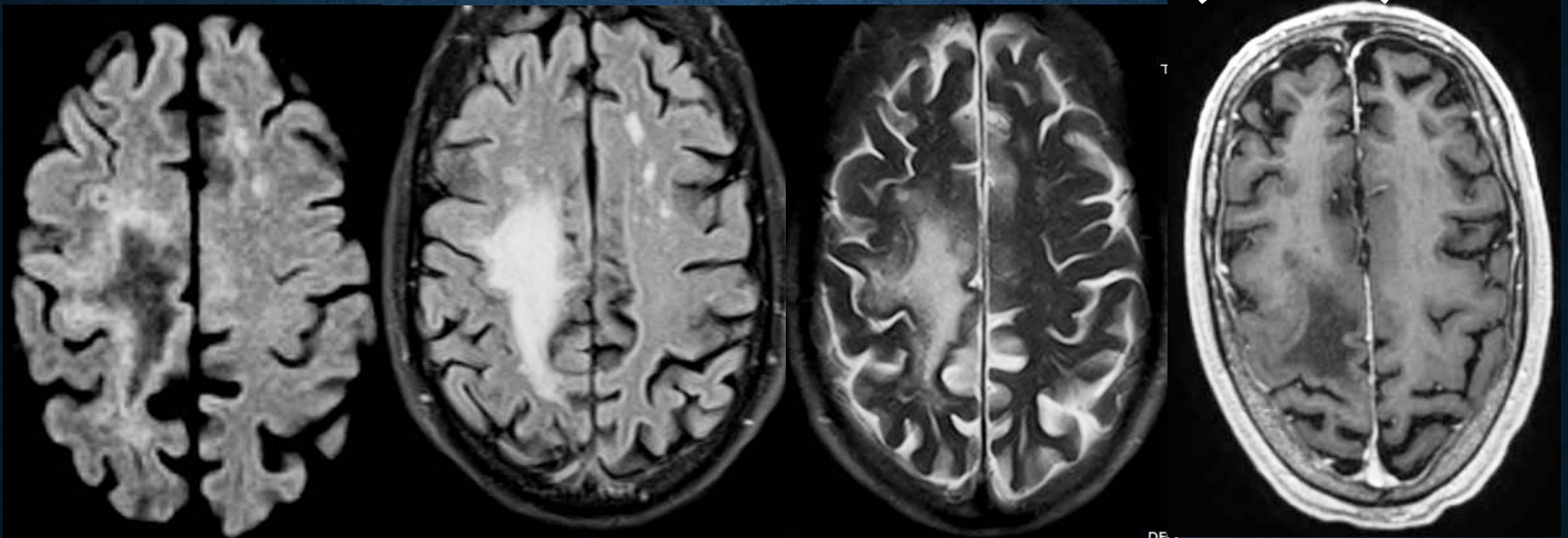


A and B are DWI views of a patient with sCJD. A demonstrates what has been called both the pulvinar sign and the hockey stick sign (arrow pointing to the pulvinar). The other arrows point to the increased DWI signal which is present throughout the cortical ribbon.

HEIDENHAIN VARIANT CREUTZFELDT-JAKOB DISEASE



PROGRESSIVE MULTIFOCAL LEUKOENCEPHALOPATHY (PML)



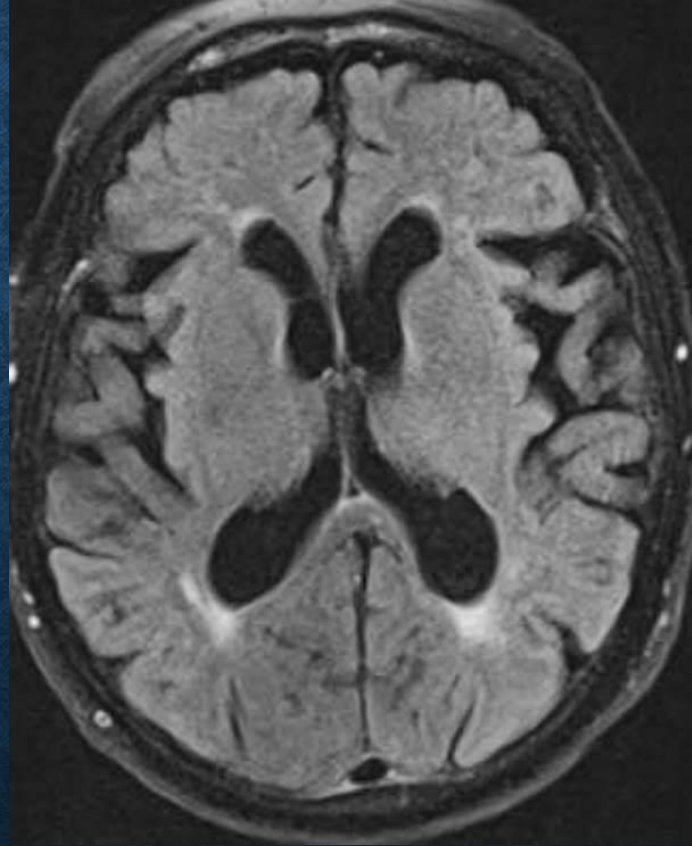
PML is a polyoma virus - JC virus (John Cunningham Virus)

Untreated PML - white matter lesions, low on T1WI, and high on FLAIR and T2WI (due to the myelin destruction), without mass effect and without contrast enhancement with no diffusion restriction centrally (but peripherally at the active site of lesion expansion with cytotoxic edema)

Immune reconstitution inflammatory Syndrome-

PML-IRIS is characterized by the development of contrast enhancement of the PML lesions and mass effect with increased high FLAIR/T2 signal due to interstitial edema.

NEUROSYPHILIS



CEREBRAL ABSCESS

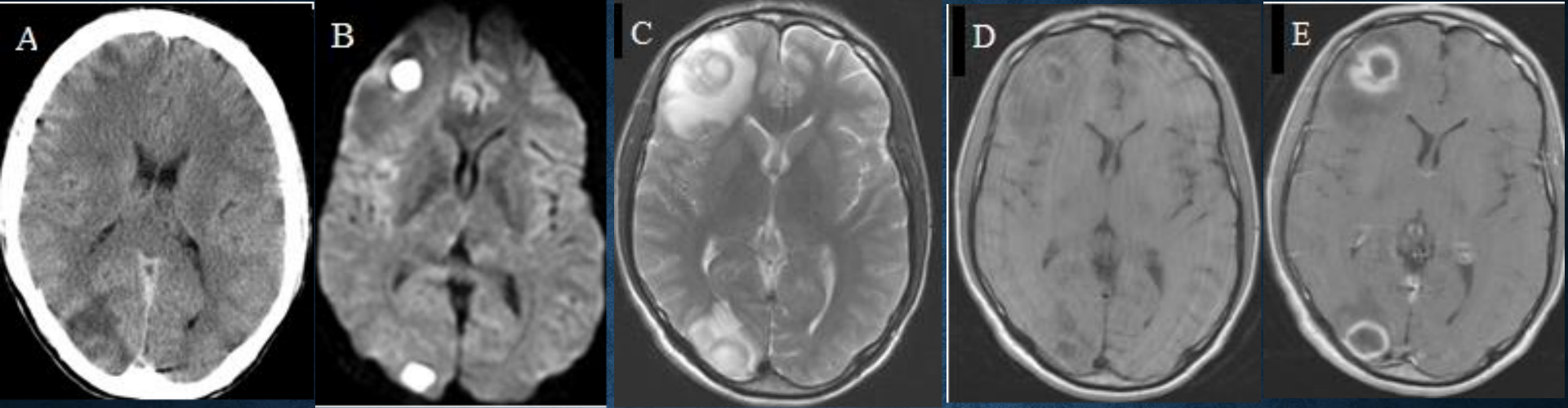
- **Cerebral abscesses are parenchymal collections of pus, immune cells and other material that is typically surrounded by a vascular collagenous capsule of granulation tissue.**
- **These generally arise from a bacterial, fungus, or parasite source and evolve one or two weeks following the initial stage of cerebritis.**

ABSCESS

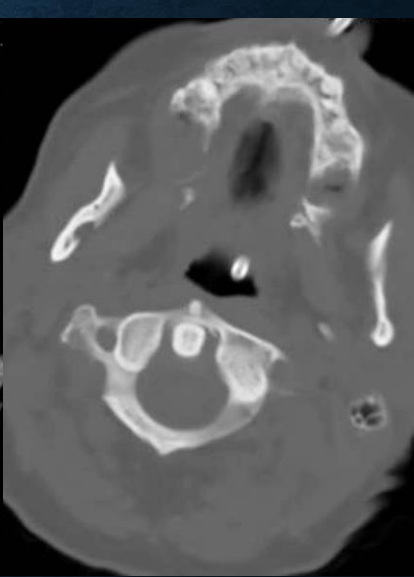
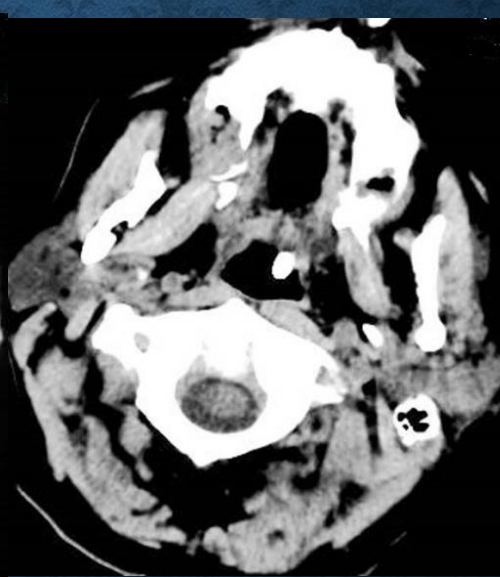
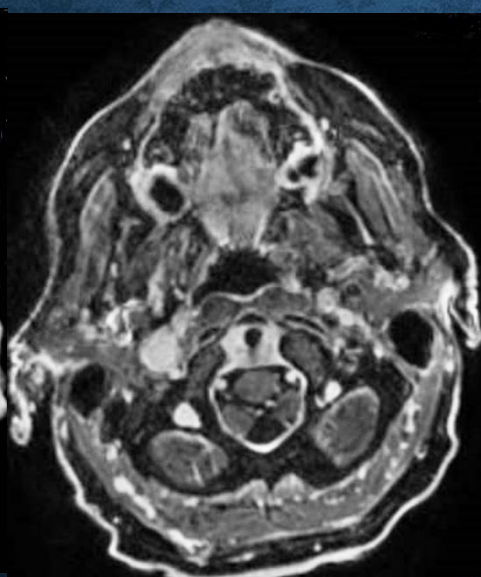
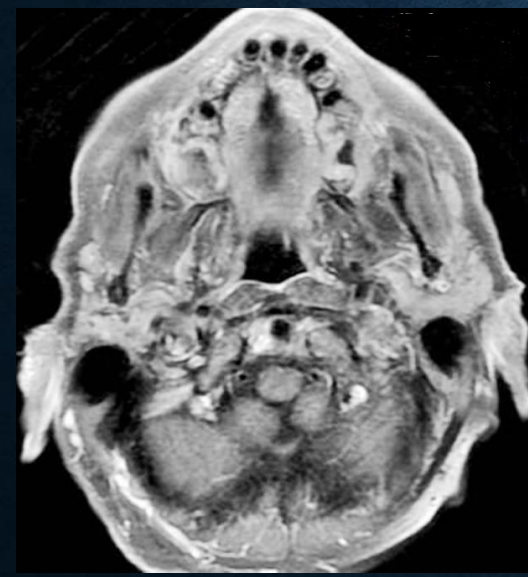
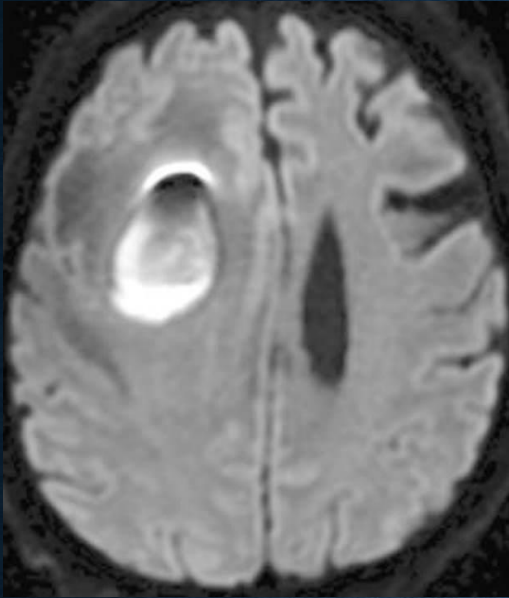
- ***Staph aureus*, Aerobic, anaerobic, and microaerophilic streptococci,**
- **Prevotella and Fusobacterium species and *B fragilis*, Enterobacteriaceae, Pseudomonas, other anaerobes,**
- ***H influenzae, Strep pneumoniae, Neisseria meningitidis,***
- **Actinomyces, Nocardia asteroides, Mycobacterium species,**
- **Fungi - Cryptococcus neoformans, Candida albicans,**
- **Protozoa- *Toxoplasma gondii, Entamoeba histolytica, Naegleria fowleri.***
- **Helminths -*Trypanosoma cruzi, Schistosoma, Paragonimus, Taenia solium,***

ABSCESS

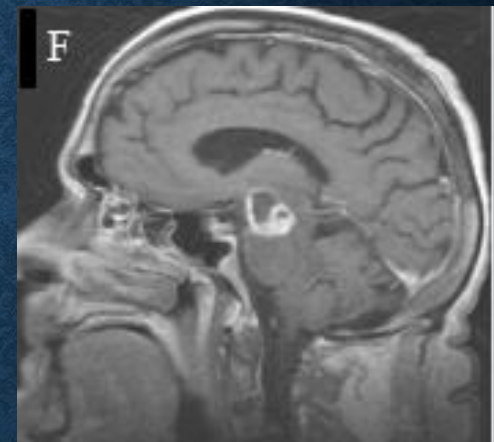
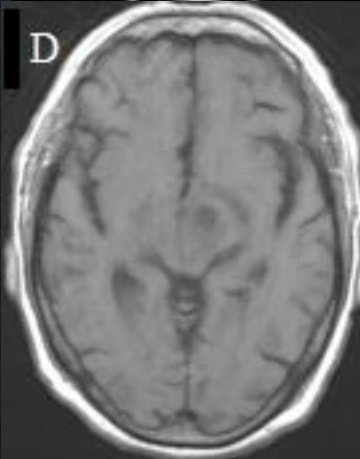
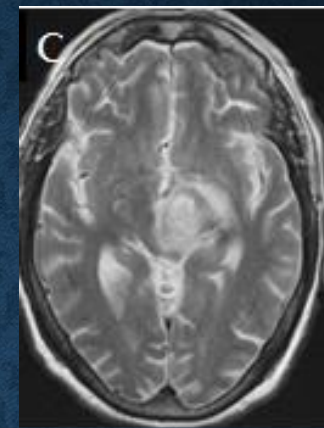
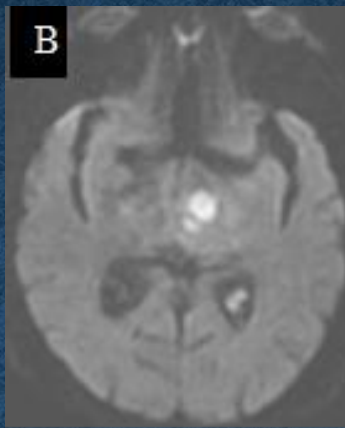
- **Blood borne infections are responsible for a large percentage of brain abscesses. These typically located in the distribution of the middle cerebral artery and most often at the gray-white junction.**
- **Infections of the mastoid sinuses are associated with abscesses in the temporal lobes or the cerebellum,**
- **Frontal, ethmoid and sphenoid sinusitis typically are associated with abscesses in the frontal lobes.**
- **Dental infections are a known cause in a small percentage of abscesses, and a more frequent suspected cause when the abscess is 'cryptogenic'.**
- **Head trauma or neurosurgery procedures**
- **Generally begin as cerebritis and evolve into abscesses.**



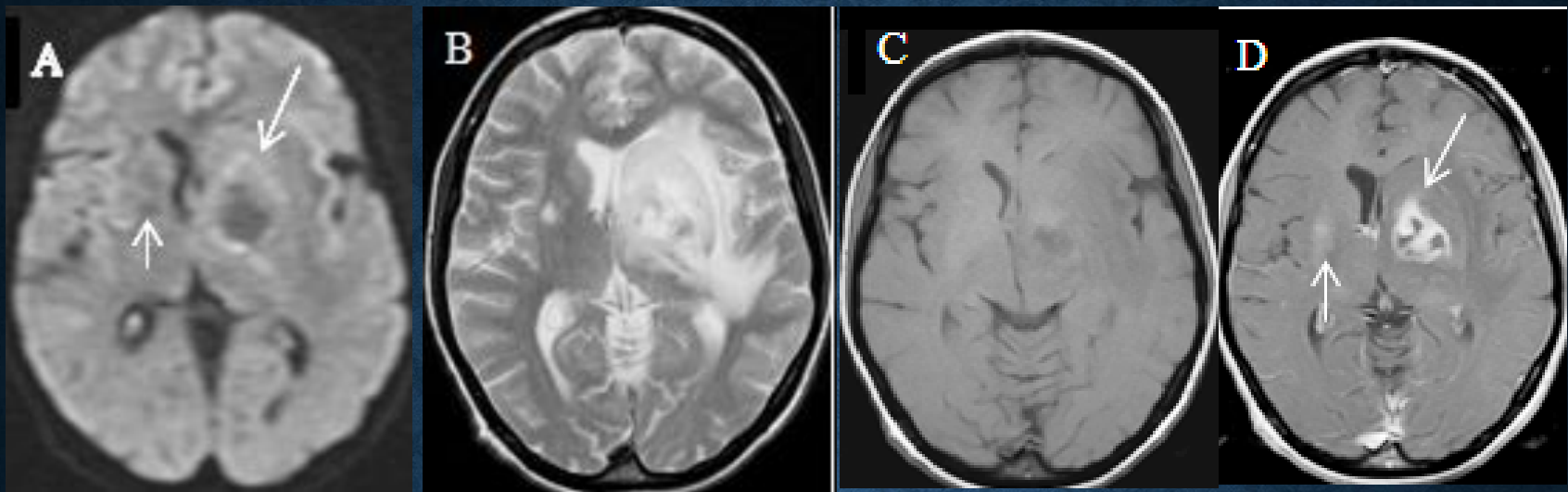
A-F demonstrate a young male patient presenting with multiple abscesses confirmed to be *Fusobacterium* which is an anaerobic bacilli likely resulted from periodontal disease.



Dental Abscess

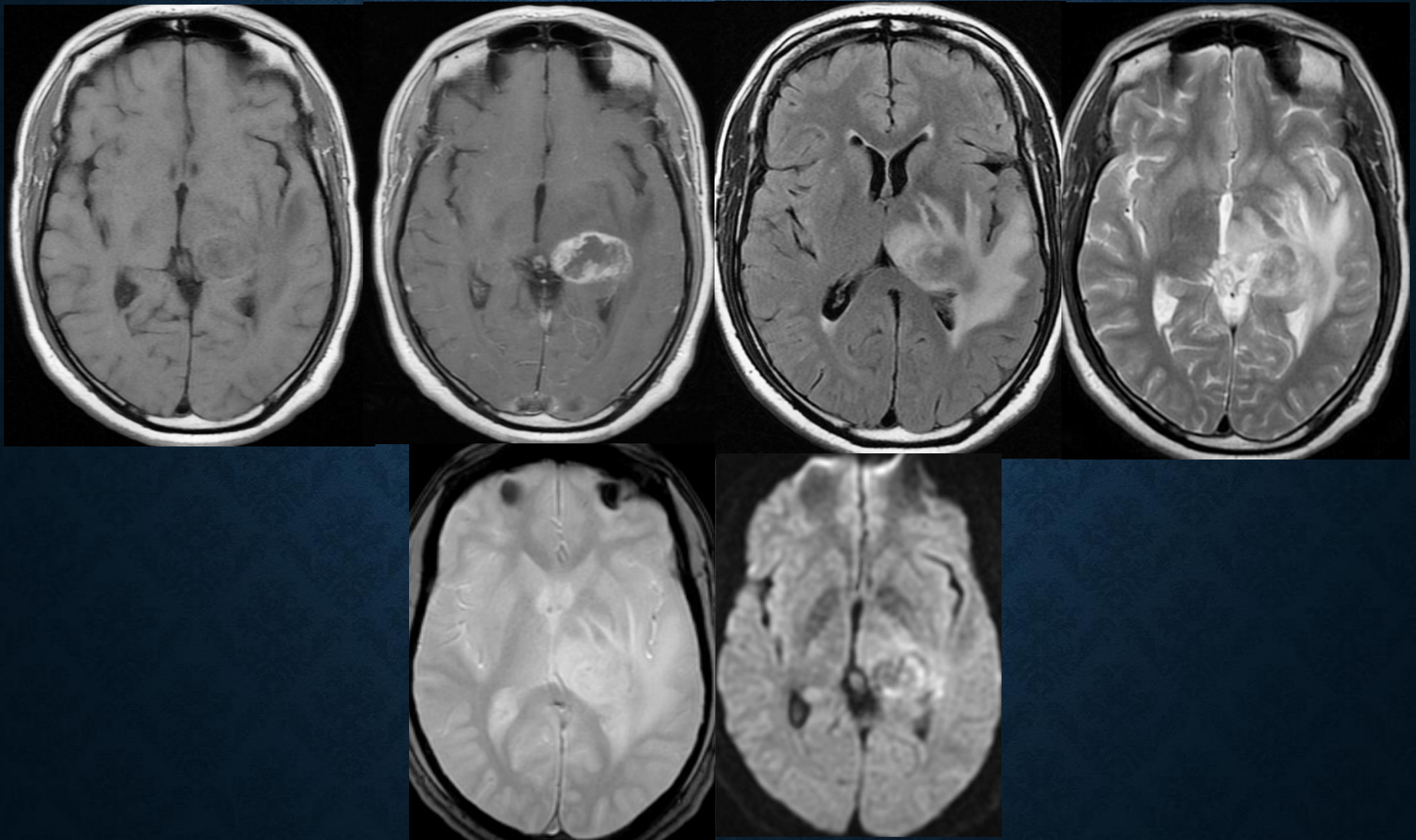


Nocardia abscess in the left thalamus and mesencephalon. A is a noncontrast CT, with a rim with increased density and adjacent vasogenic edema. B is a DWI view with restricted diffusion within the pyogenic infection. C is a T2-weighted view. D, E, and F are T1-weighted views without and with contrast, respectively, depicting the smooth margin characteristic of a pyogenic infection. The lesion is forming a satellite or daughter lesion, which is a common finding in Nocardia with its indolent development.

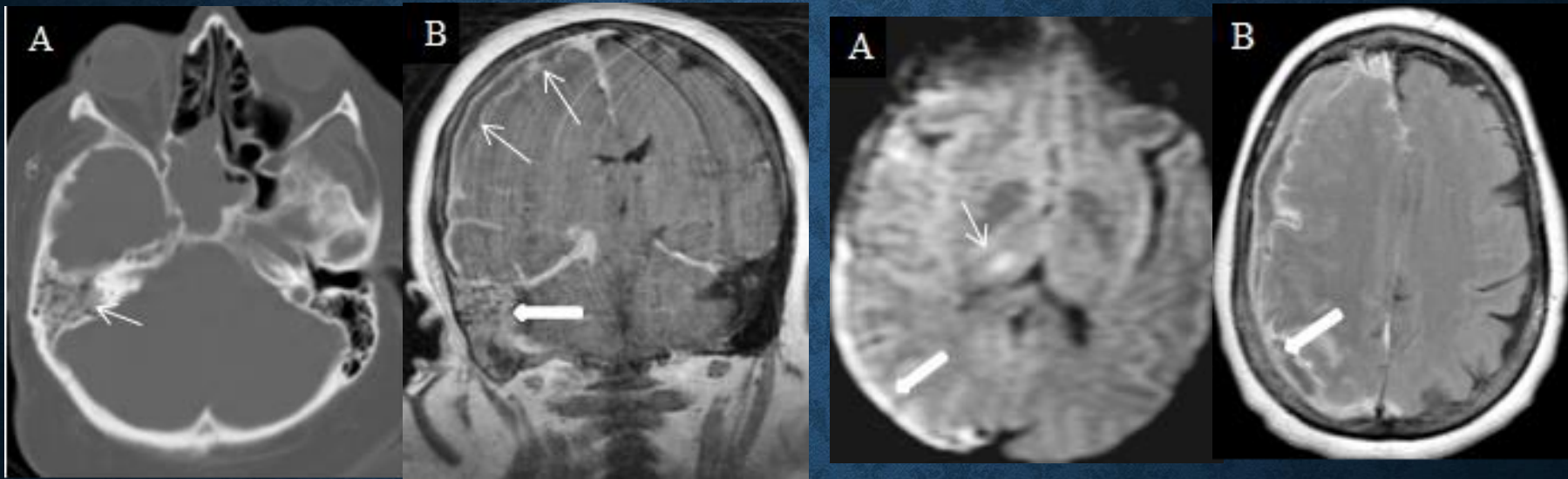


Patient is HIV positive and presents with toxoplasmosis. A is a DWI view that shows the decreased central diffusion signal with a perimeter of relative increased diffusion (arrows). Unlike pyogenic infections, infections such as Toxoplasmosis have necrotic centers which lack purulent fluid. They are nevertheless inflammatory, as demonstrated on B. The left basal ganglion abscess shows marked increased signal and mass effect. C and D are T1, non- and post-contrast views, respectively, with arrows pointing to the enhancing abscesses

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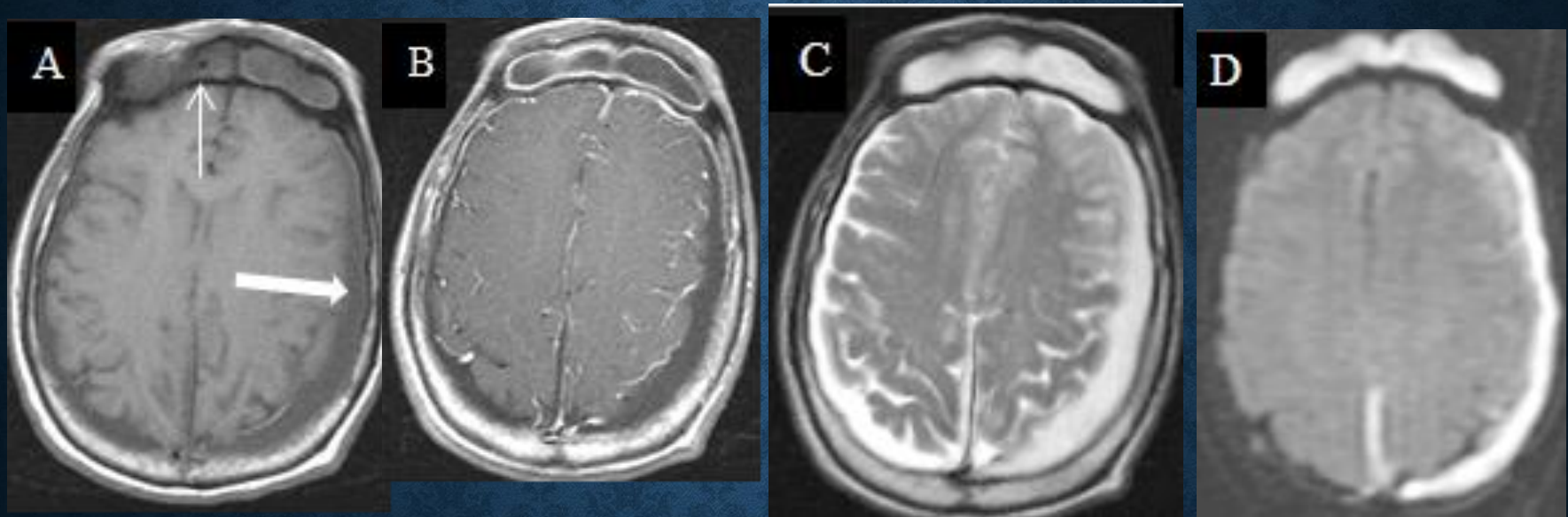


MASTOIDITIS WITH EMPYEMA



CT and MRI of a patient with a right hemispheric empyema. Initial A is a bone windowed CT. Second A is a DWI view demonstrating the increased signal in the subdural space, due to the purulent fluid (large arrow). The small arrow points to an acute infarction due to vasculitis associated with the CNS infection. B is a FLAIR-weighted view demonstrating increased signal along the pia and dura mater as a result of the purulent fluid.

SINUSITIS WITH EMPYEMA

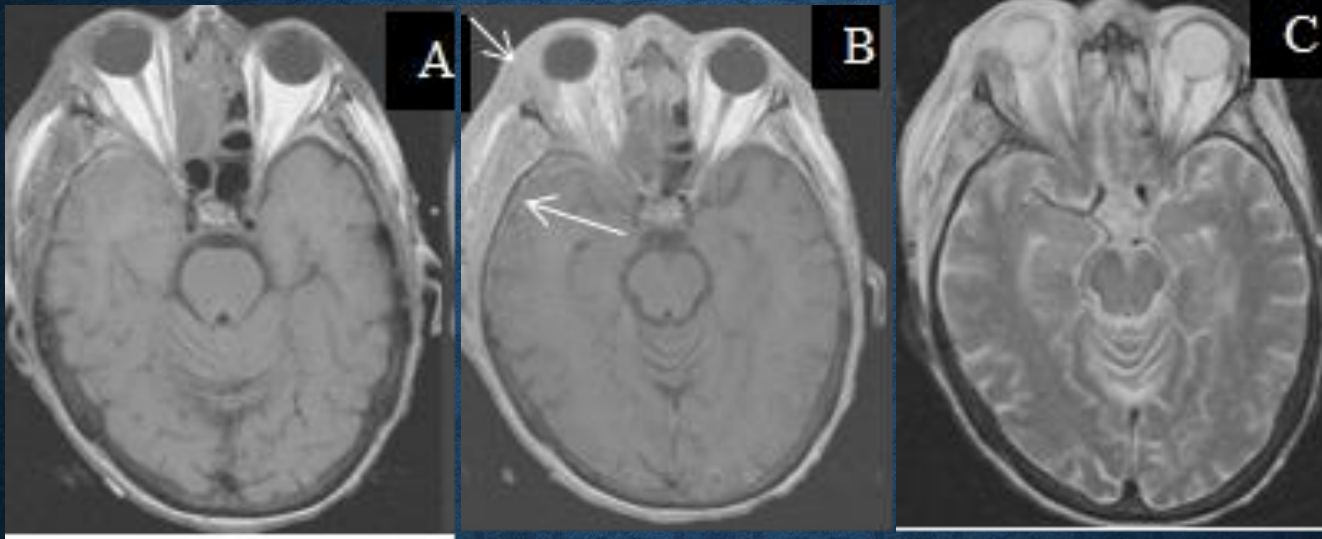


MRI of a patient with a left hemispheric empyema associated with acute frontal sinusitis. A and B depict T1-weighted views without and with contrast, respectively. The small arrow points to the frontal sinusitis larger out to the left hemispheric empyema. C is a T2-weighted view demonstrating the increased signal of the sinusitis and empyema. D is a diffusion-weighted view demonstrating the bright DWI signal associated with purulent infection.

MENINGITIS / CAVERNOUS SINUS THROMBOSIS

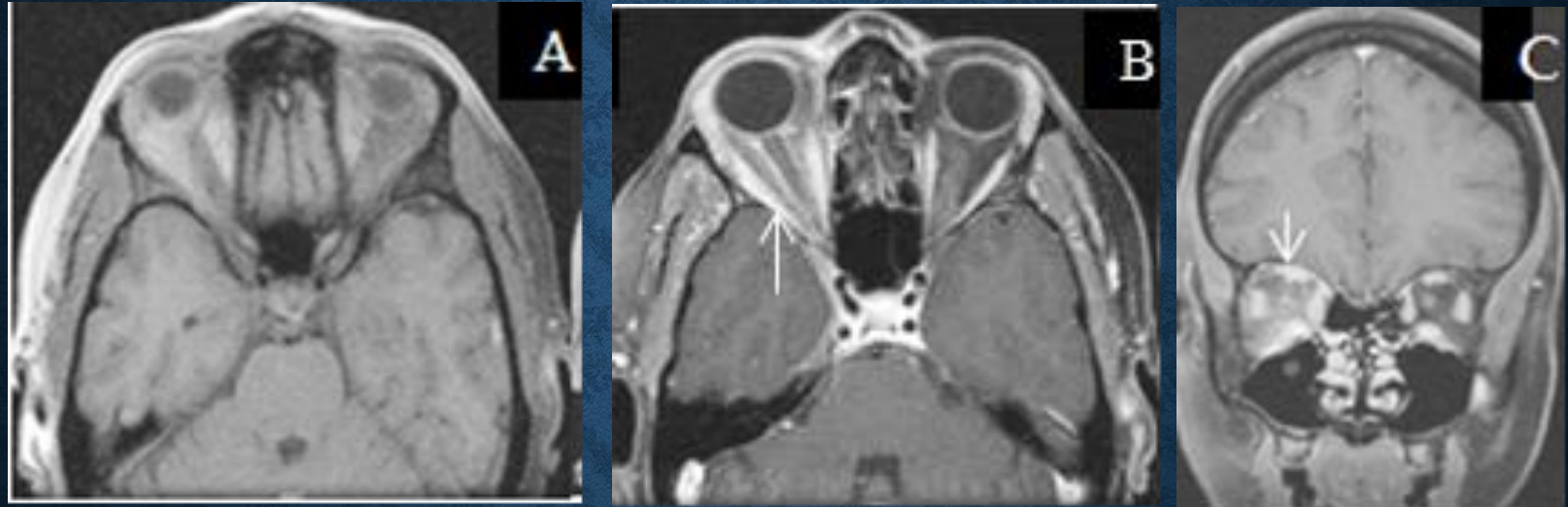


ORBITAL ABSCESS



MRI of a patient with a right facial and frontal cellulitis, an orbital abscess and ethmoid sinusitis. A is a noncontrast T1, B a postcontrast T1-weighted view, small arrow pointing to the enhancing infection, large arrow to the soft tissue cellulitis. C is a T2-weighted view of the same region, again demonstrating the swollen soft tissue and intraorbital inflammatory changes.

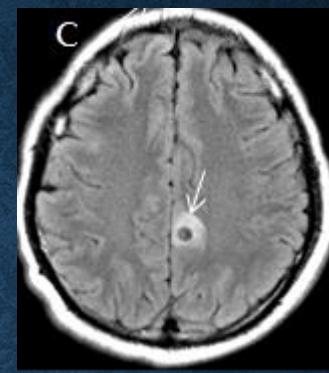
ORBITAL CELLULITIS



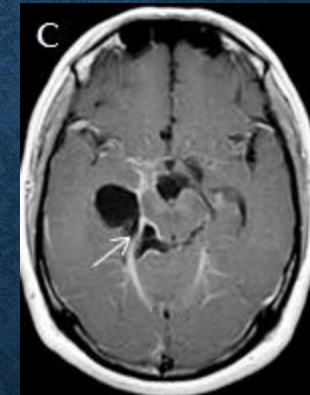
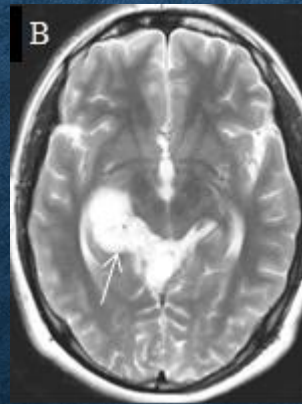
These are T1-weighted orbital views in a patient with right eye orbital pseudotumor due to Lyme disease. Figure A is a noncontrast T1 weighted view without the fat saturation pulse. Figures B and C are postcontrast Fat-Sat T1 weighted views in the axial and coronal planes and show enhancement within the right orbital soft tissue best demonstrated by saturating the signal from the normal intracranial fat tissue.

NEUROCYSTICERCOSIS

- **Neurocysticercosis is the most common helminthic infection in the CNS and a major cause of seizure.**
- **Four stages:**
 - **a. Vesicular- thin collagen capsule, viable scolex**
 - **b. Colloidal- intense inflammatory reaction and thick capsule.**
 - **c. Granular- thick wall, degenerative scolex**
 - **d. Calcified- calcified nodules**



A an arrow points to a small cyst on a noncontrast CT. **B** demonstrates a small calcified cyst, an end-stage necrotic cysticercoid. **C** arrow points to a cyst similar to the cyst depicted in figure **A** on a FLAIR-weighted view and demonstrates an associated inflammatory changes within the adjacent cortex and white matter.

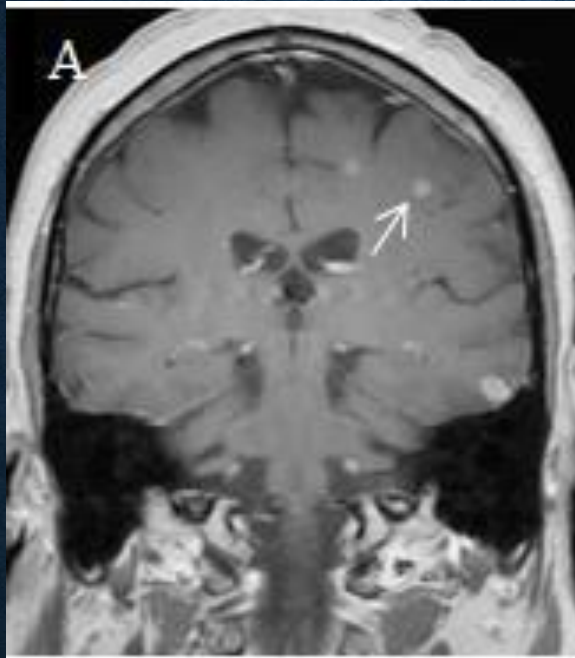


A is a CT view with neurocysticercosis within the arachnoid spaces. The arrows point to cystic enlargement in the arachnoid spaces of the left Sylvian and the interhemispheric fissures. **B** and **C** are T2 and postcontrast T1-weighted views, respectively, the arrows pointing to both dural enhancement (**C**) as a result of the meningeal cysts in the subarachnoid space and are termed racemose.

TUBERCULOSIS

- **Tuberculosis infections of the CNS are seen predominately in patients with immune compromise or foreign travel particularly Asia and Africa. Imaging range from basilar meningitis with thick nodular enhancing dura to rarely tubercular abscesses in the brain parenchyma. Hydrocephalus, cranial neuropathies and vasculitis can result from the basilar meningitis.**

TUBERCULOSIS



Post-contrast T1-weighted coronal and axial views, respectively of a patient with AIDS, hepatitis, and tuberculosis. These figures demonstrate small military abscesses of this indolent infection (arrow in A) along with basilar meningitis (arrows in B).

- **Capone, P.M., Scheller, J.M. Neuroimaging of Infectious Disease.** Neurologic Clinics. Volume 32, Issue 1, 127-145. Edited by Laszlo L. Mechtler. February, 2014