



Susceptibility Weighted Imaging

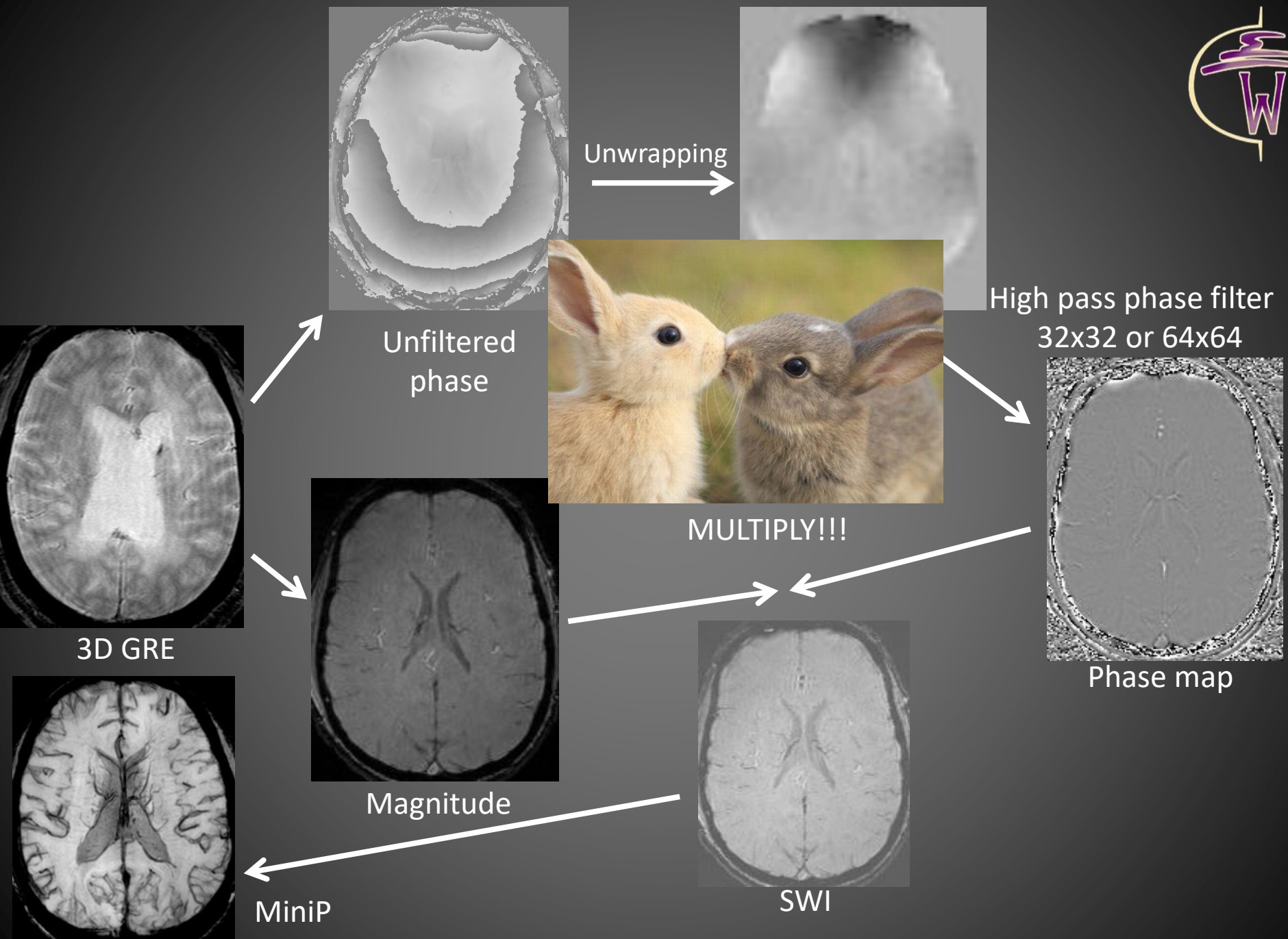
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Susceptibility Weighted Imaging

- What is it?
 - 3D fully-velocity compensated gradient echo sequence
 - Post-process to take advantage of differential susceptibility of paramagnetic and diamagnetic substances



Comparison

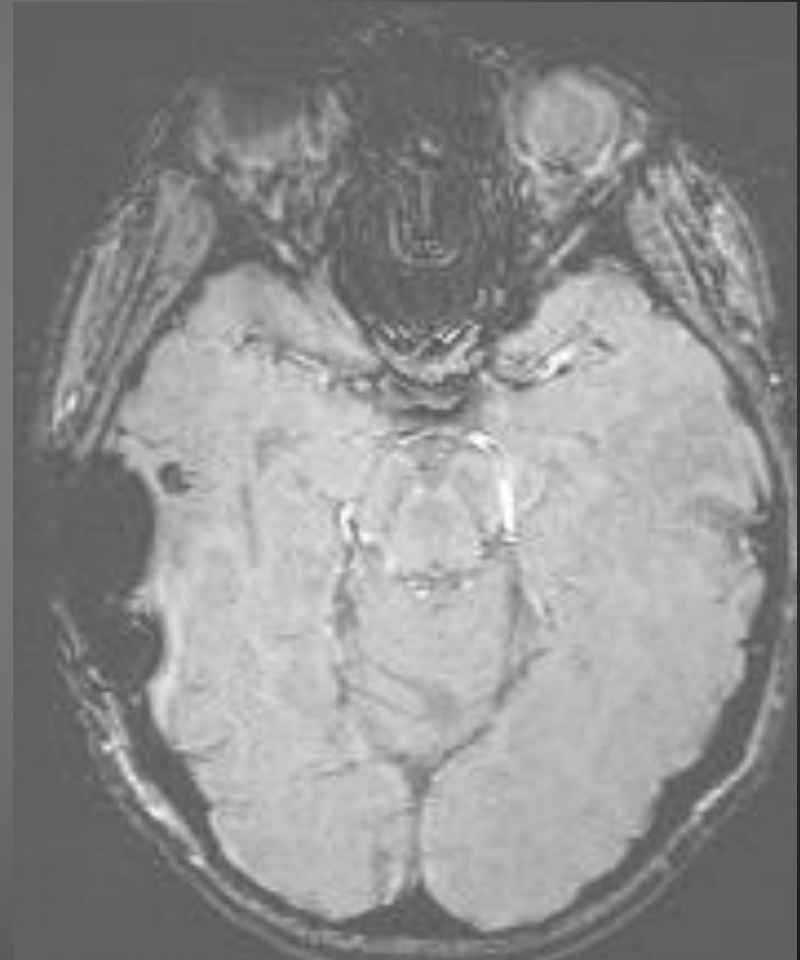


	2D Gradient Recalled Echo	SWI
Slice Thickness	4-5 mm, 1 mm interslice gap	1.2-1.5 mm slice thickness
Resolution	2x2 mm	.8x.8 – 1.5x1.5 mm
Imaging Time	2:36 minutes	4-8 minutes
Differential susc.	No	Yes
TE length	Short TE	Long TE
Post-proc.	No	Yes

SWI Parameters



- TE
 - Long TE provides increased susceptibility and conspicuity of small hemorrhages
 - Increased susceptibility at skull base
 - Short TE: Decreased artifact, less blooming



SWI Parameters

- Isotropic imaging allows for multiplanar reformatting
- Increasing resolution reduces volume averaging at the skull base and also reduces susceptibility artifact



Differential Susceptibility on SWI

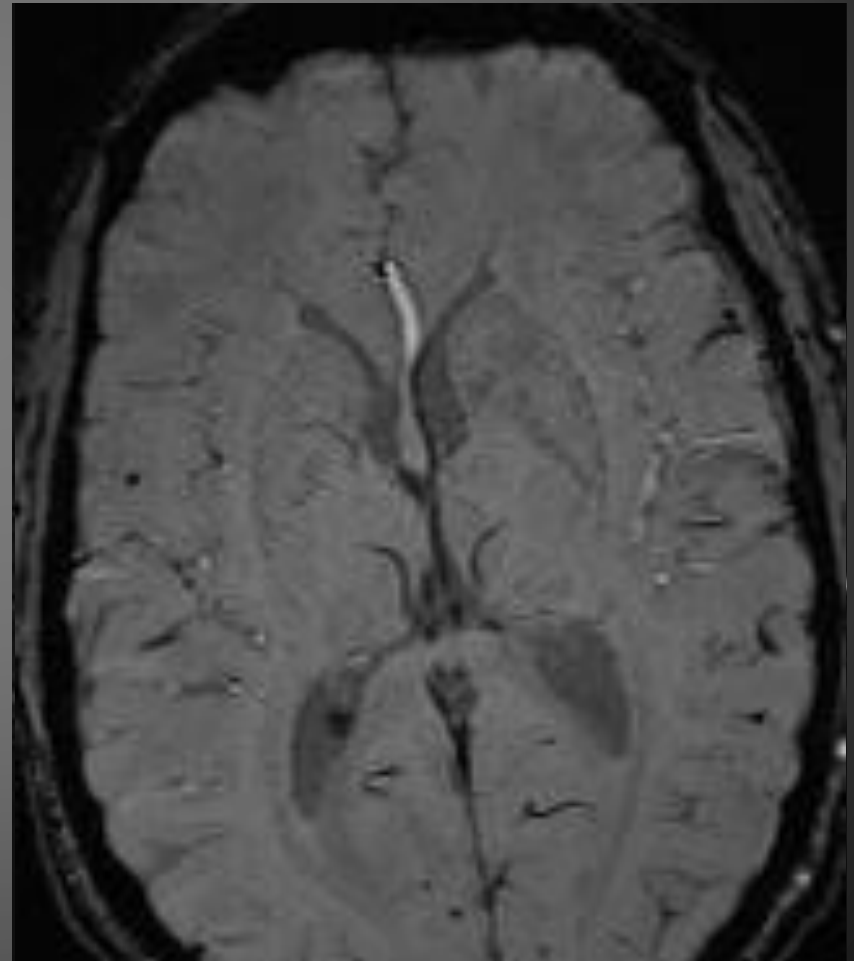
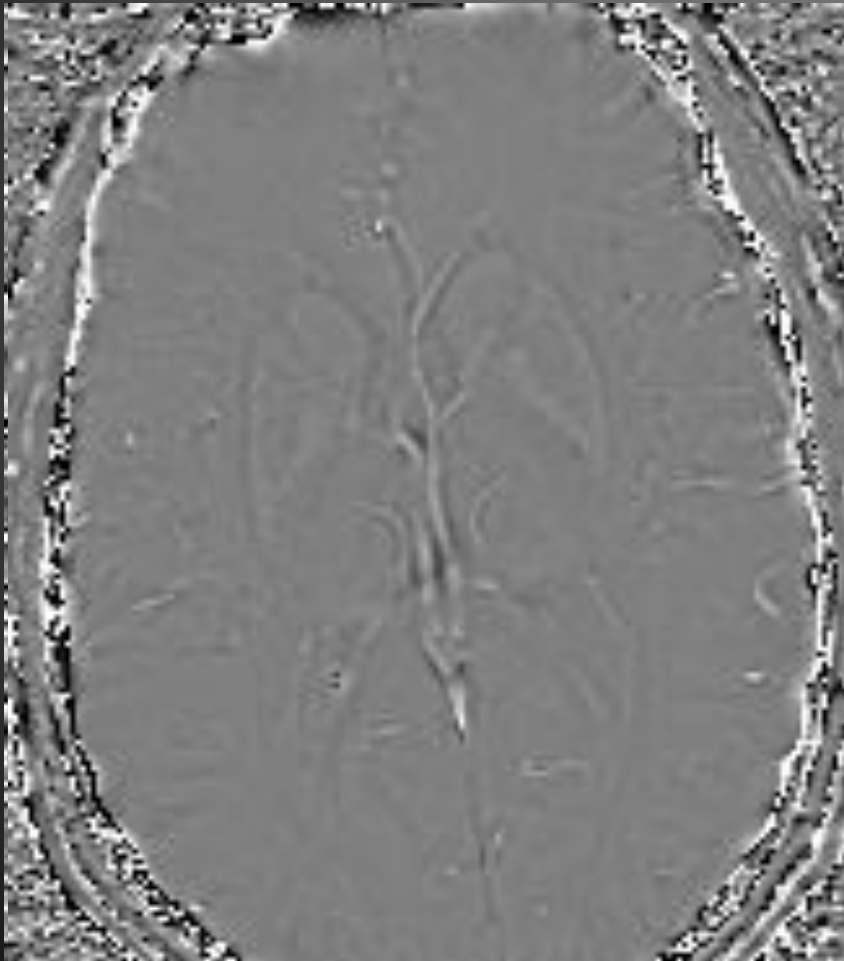
SWI can allow for differentiation between paramagnetic and diamagnetic substances

SWI	Right Handed	Left Handed
Paramagnetic (deoxy Hgb, Hemosiderin, iron)	Dark	Bright
Diamagnetic (Calcs, oxyHgb, extracellular metHgb)	Bright	Dark

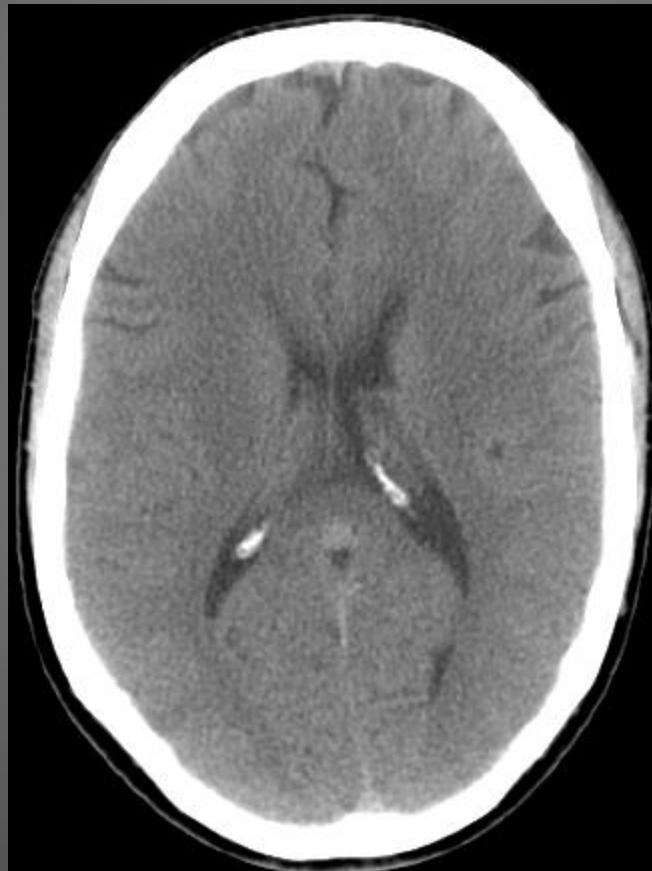
Siemens: Always left handed

GE: Always right handed

Differential Susceptibility



Choroid Plexus Calcifications





Limitations

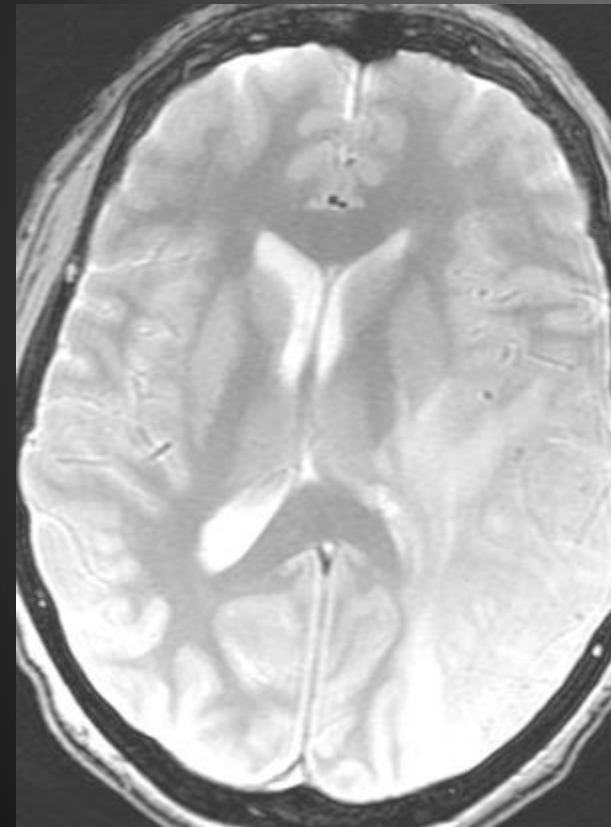
- Phase aliasing
 - With high TE, can get phase aliasing with highly paramagnetic material
 - Large or even small hemorrhages



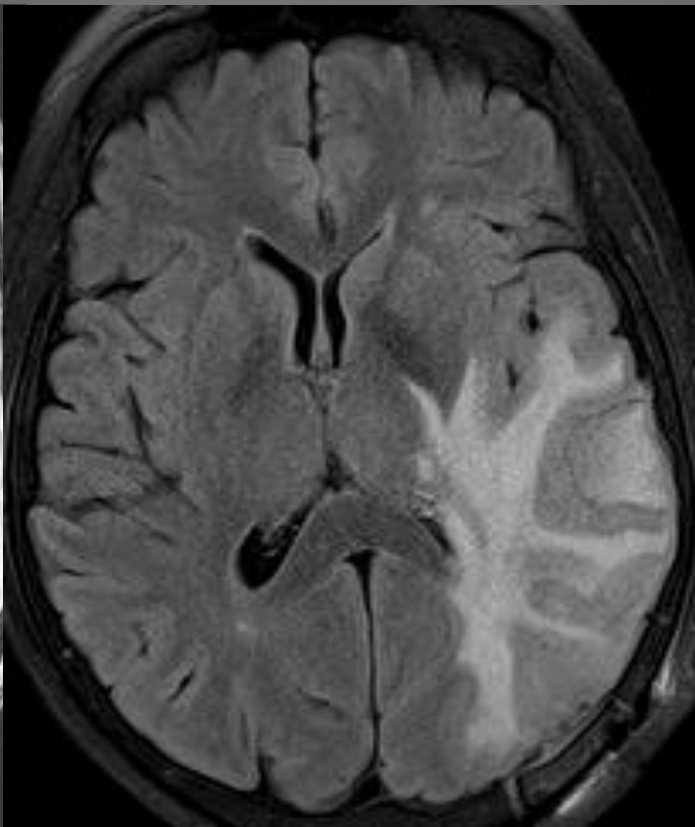
Sensitivity to microhemorrhages

- SWI 40%-300% more sensitive to microhemorrhages than 2D GRE
- Microhemorrhages present on GRE not prospectively seen
 - Better appreciated on SWI
- Importance in diagnosis of cerebral amyloid, cerebral fat embolism/trauma
- Stroke intervention??

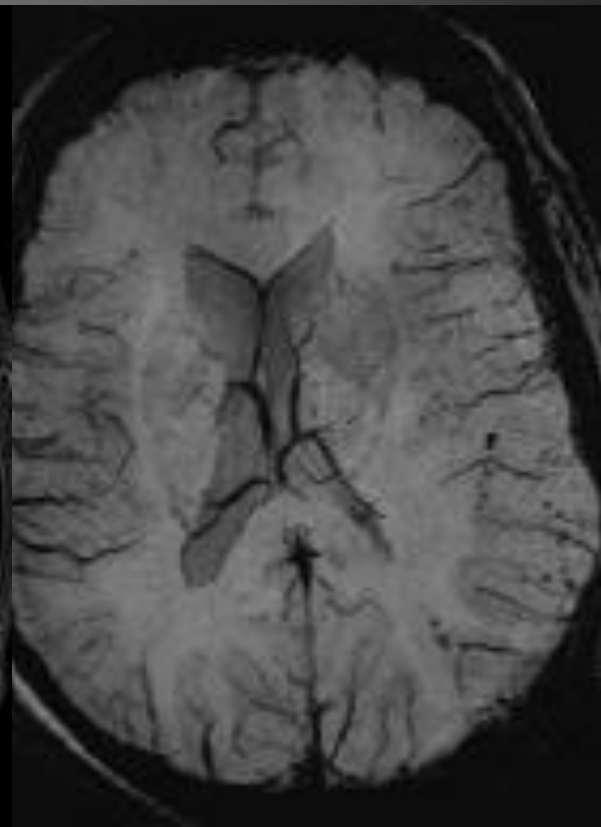
Inflammatory Amyloid



2D GRE

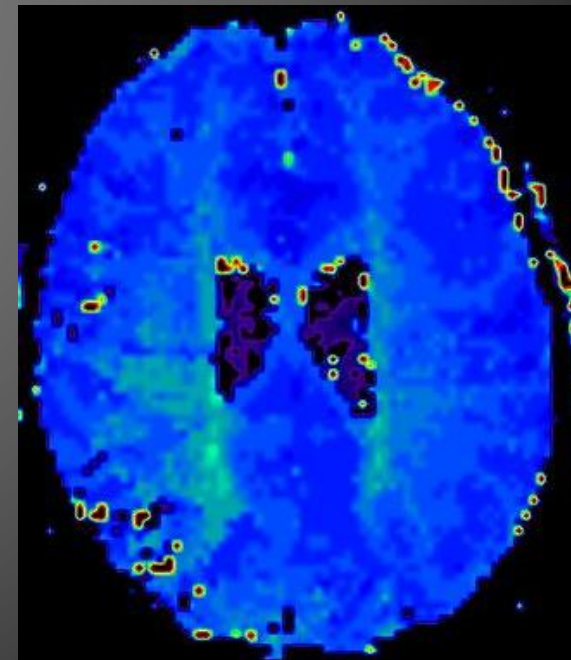
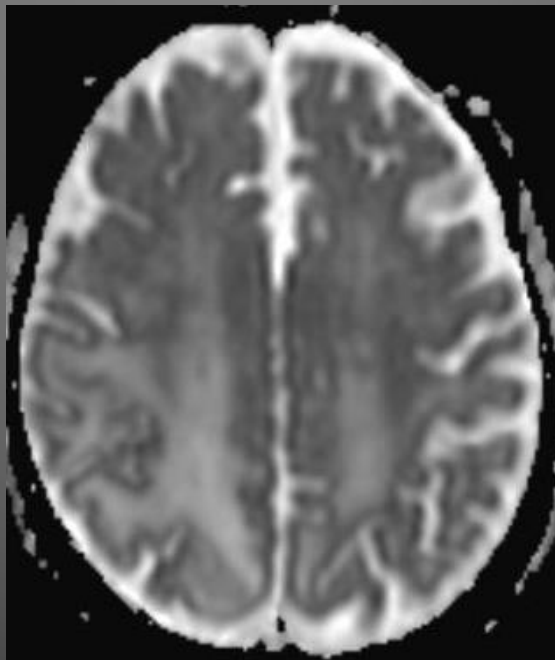
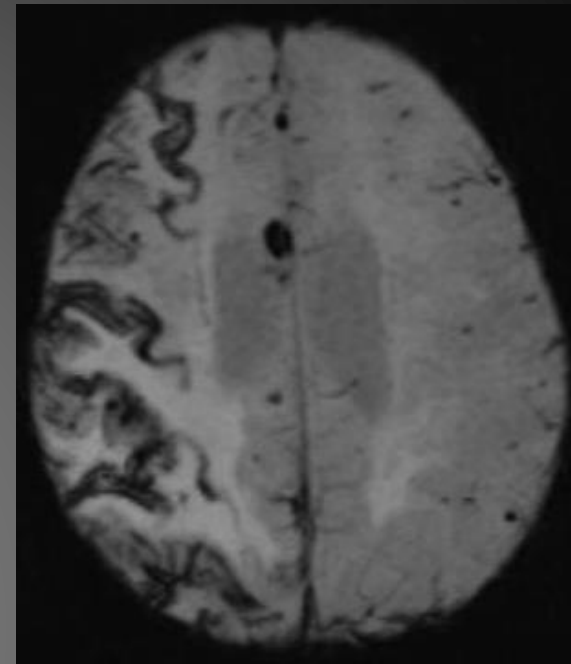
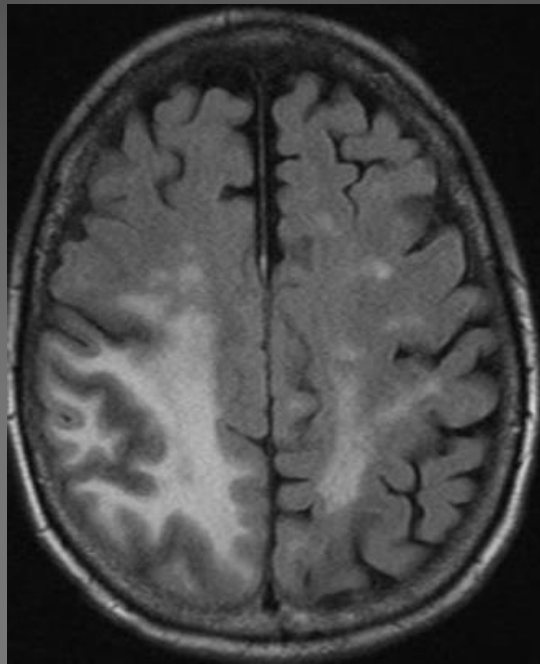


STIR MRI



SWI MRI

- Inflammatory amyloid
 - Amyloid related angiopathy





Inflammatory amyloid

- Also known as A β -related angiitis
- Two forms of inflammatory amyloid
 - CAA-related inflammation
 - Perivascular non-destructive vascular inflammation
 - A β -related angiitis
 - Transmural, vasculitic, granulomatous inflammation
 - May be more closely related to PACNS than CAA



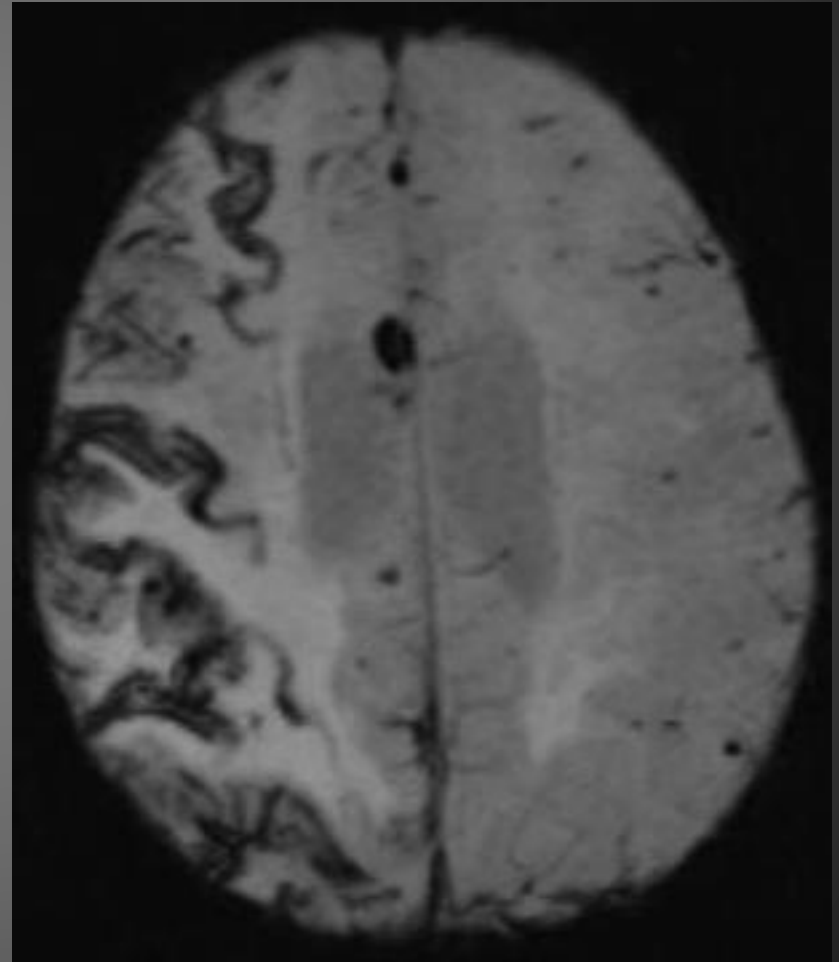
A β -Related Angiitis

- Younger than normal CAA patients
- Rapid progression of disease
 - Cognitive decline
 - Neurological deficits
 - Progress to death rapidly without therapy
- Treatment: Immunosuppression

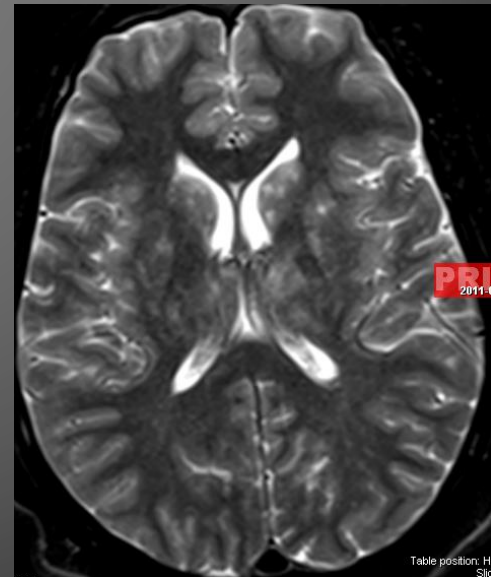
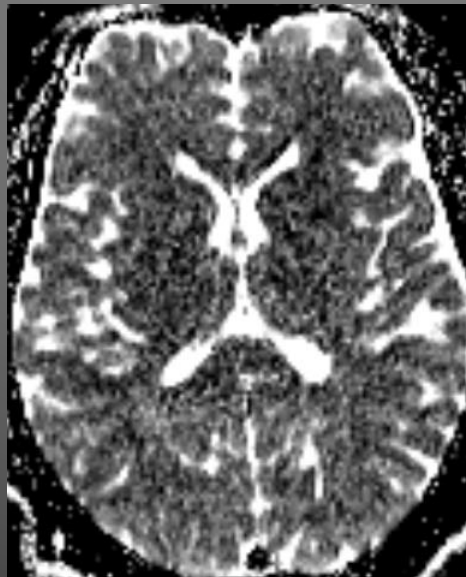
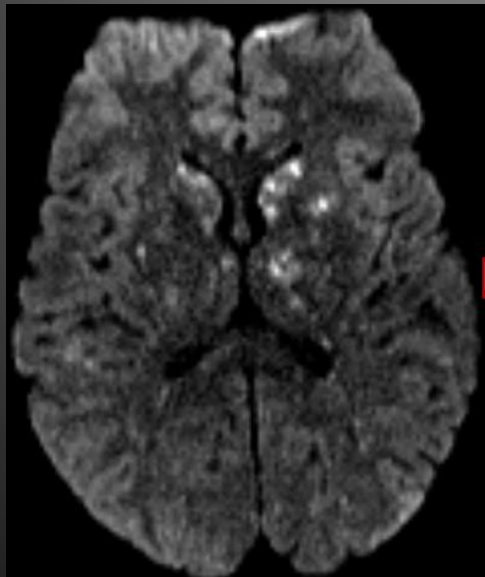
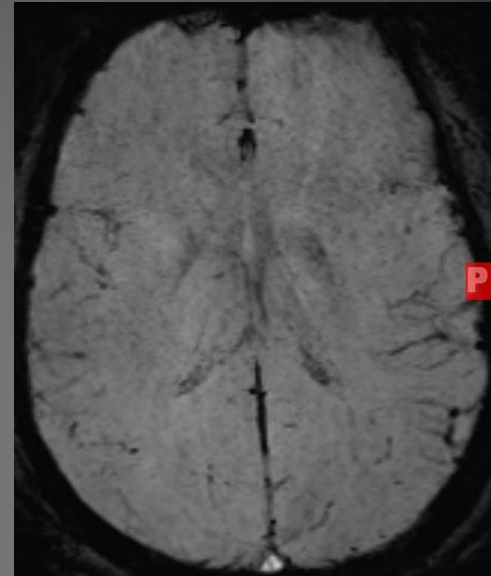
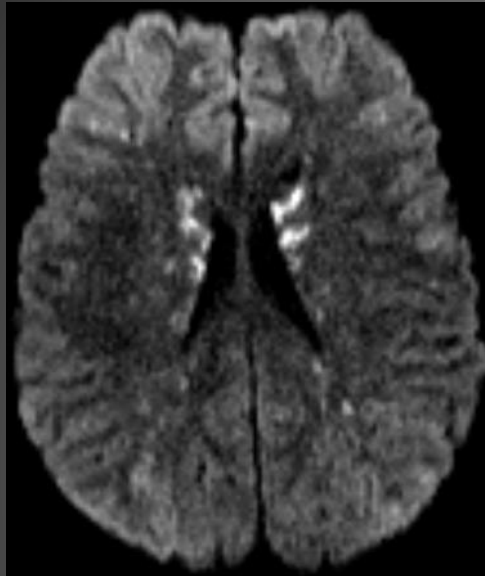
A β -Related Angiitis

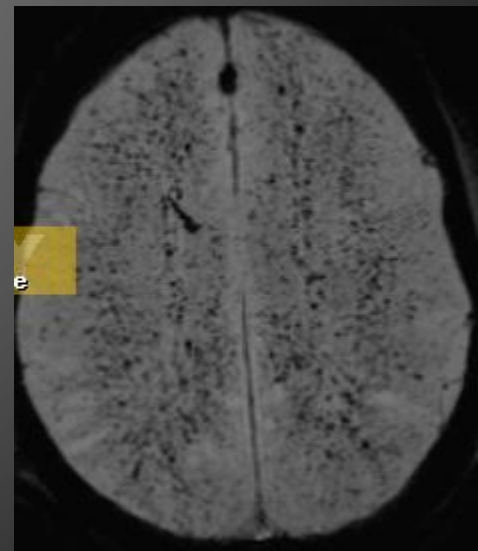
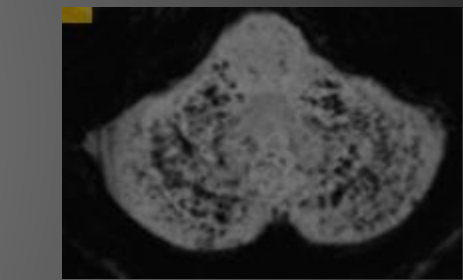
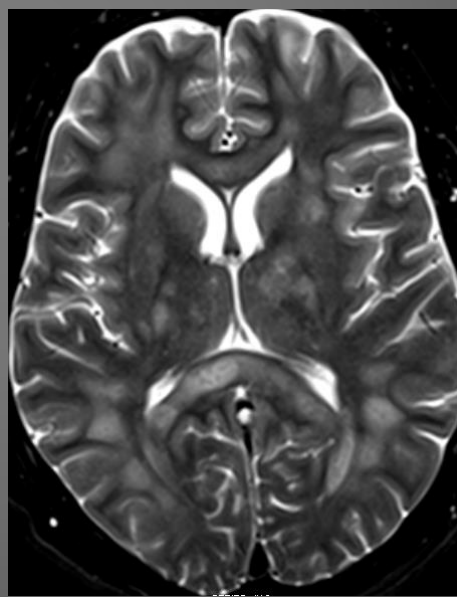
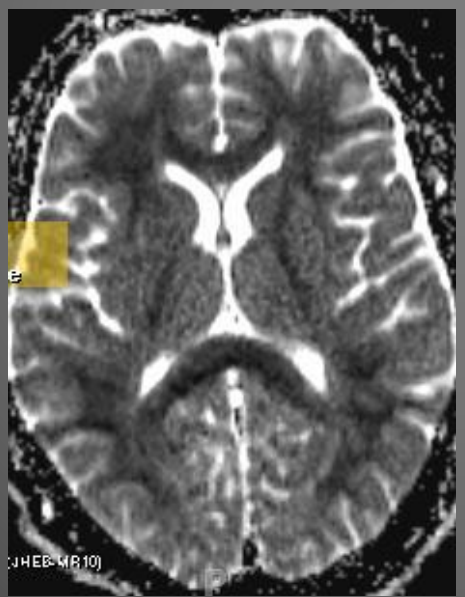
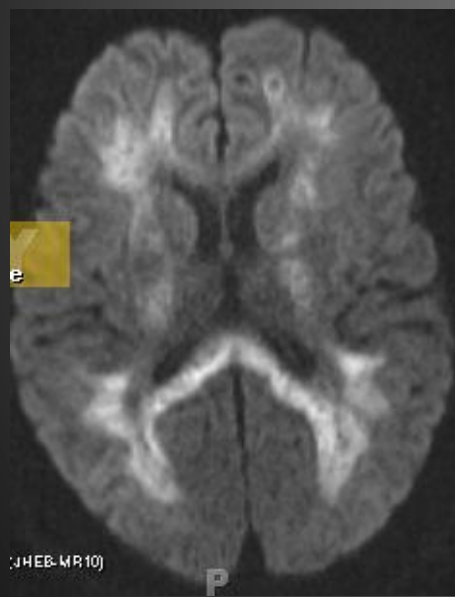
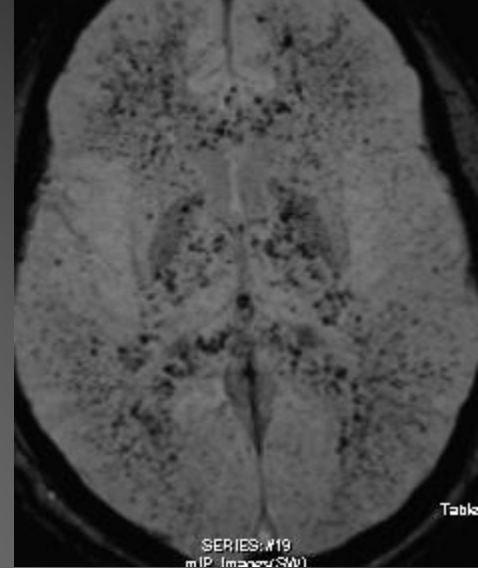
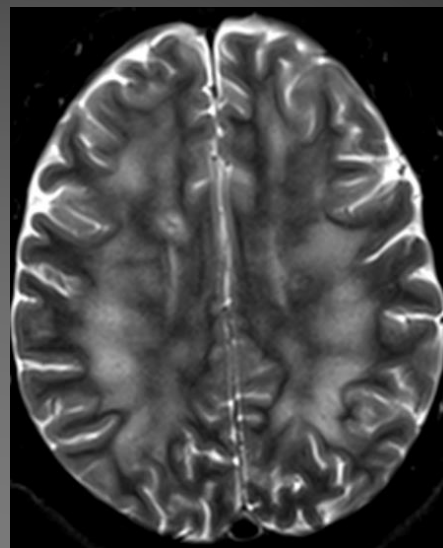
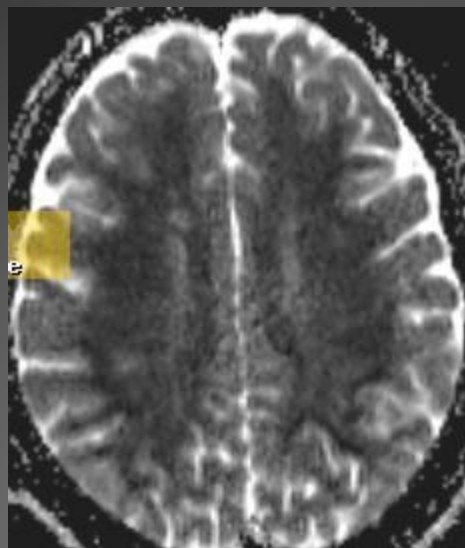
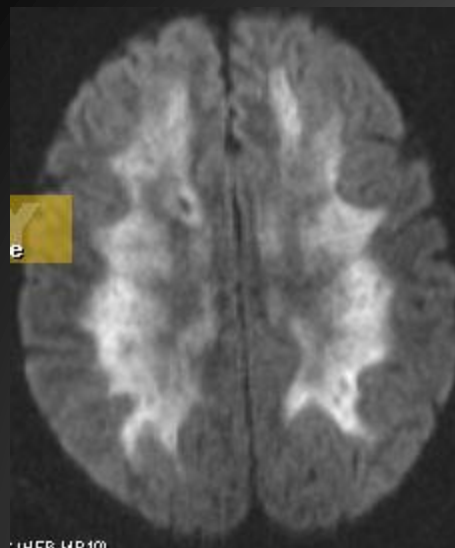


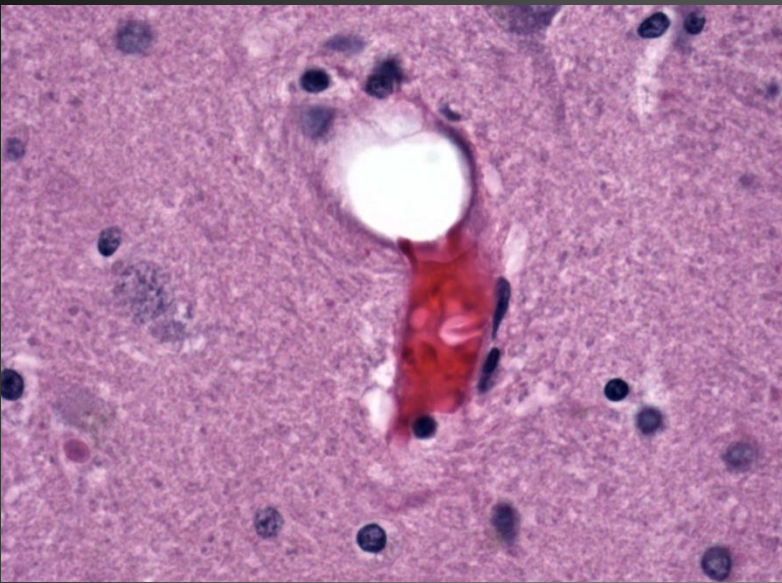
- Imaging Findings:
 - MR
 - Asymmetric edema
 - Amyloid related hemorrhages
 - Punctate
 - Lobar
 - Subarachnoid
 - Decreased perfusion
 - Leptomeningeal enhancement



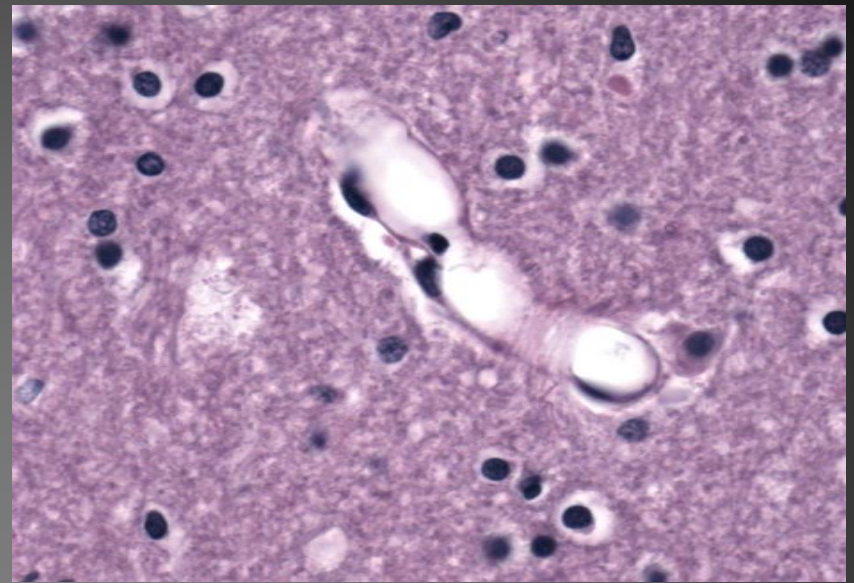
Cerebral Fat Embolism in SCA



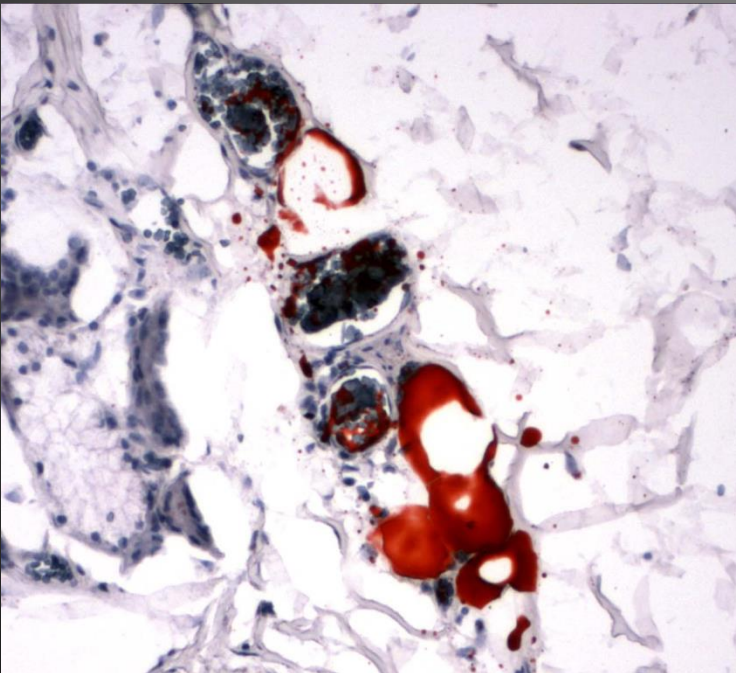




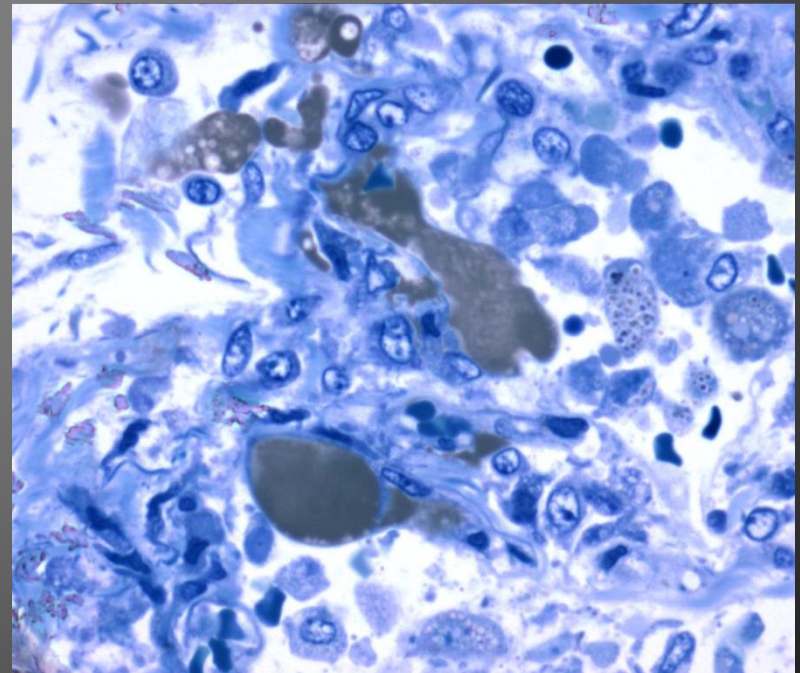
Right thalamus



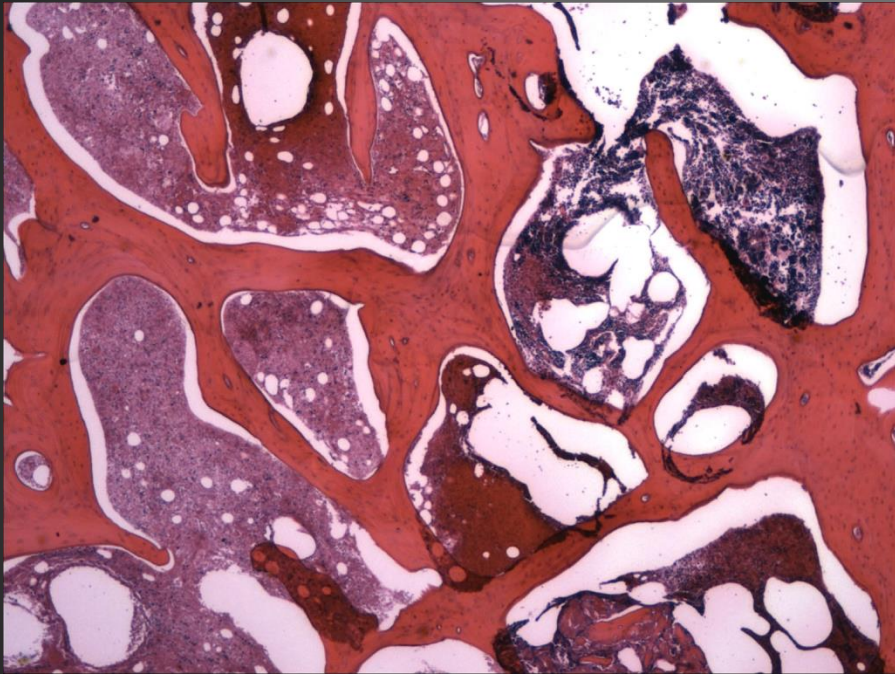
Left cerebellum



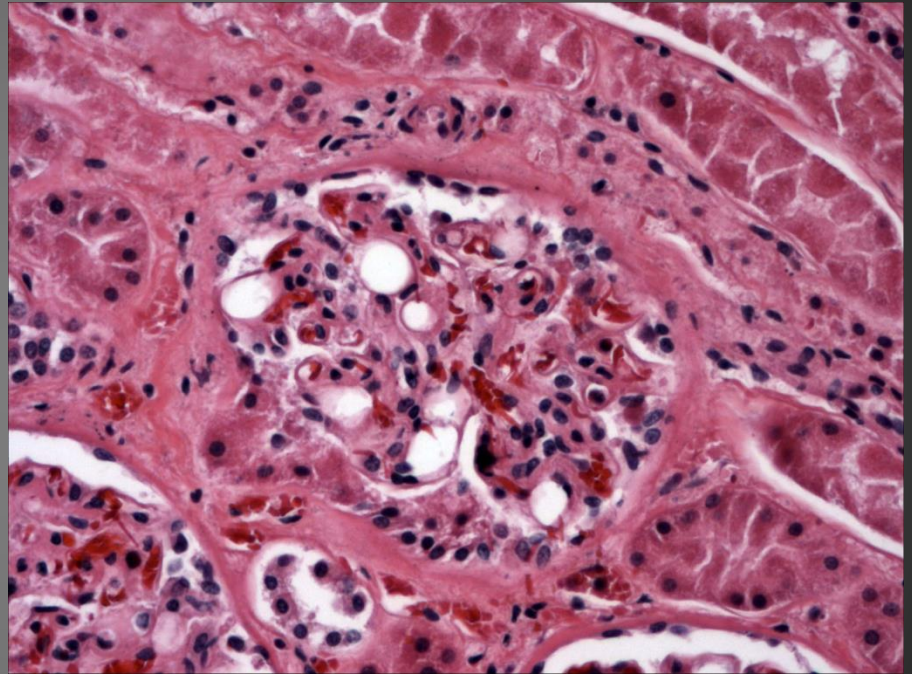
Lung- Oil Red O Stain



Lung- Osmium Stain



Bone Marrow Infarct



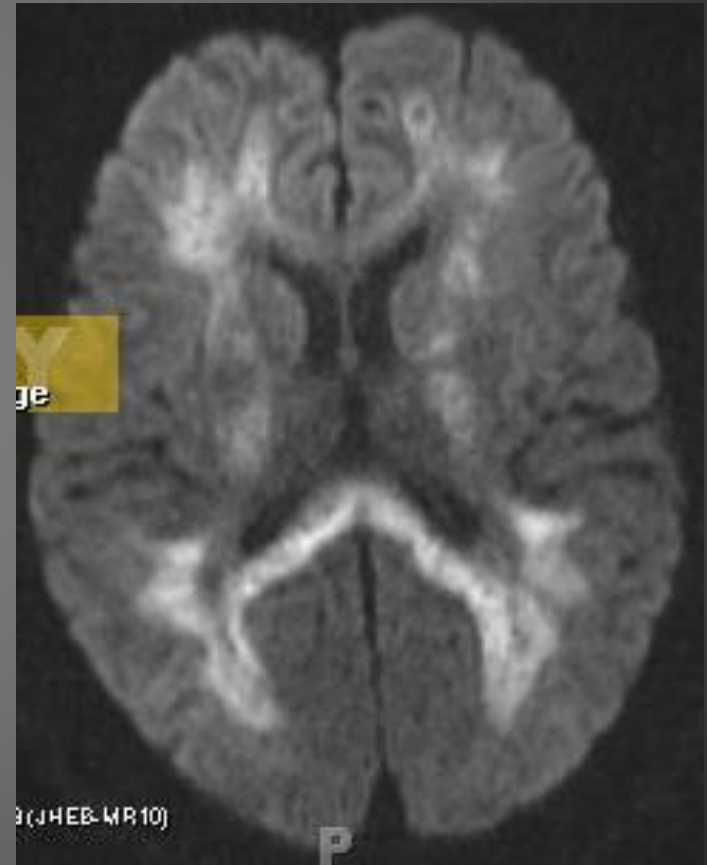
Renal glomerulus- Fat emboli

Cerebral Fat Embolism

- Can arise secondary to long bone trauma or SCA
- Mechanisms of injury:
 - Free fatty acids
 - Mechanical obstruction
 - Chylomicron formation

Cerebral Fat Embolism

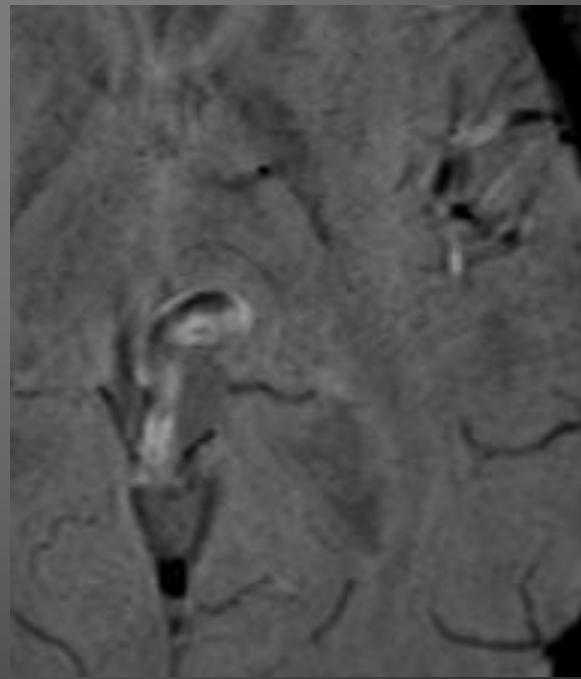
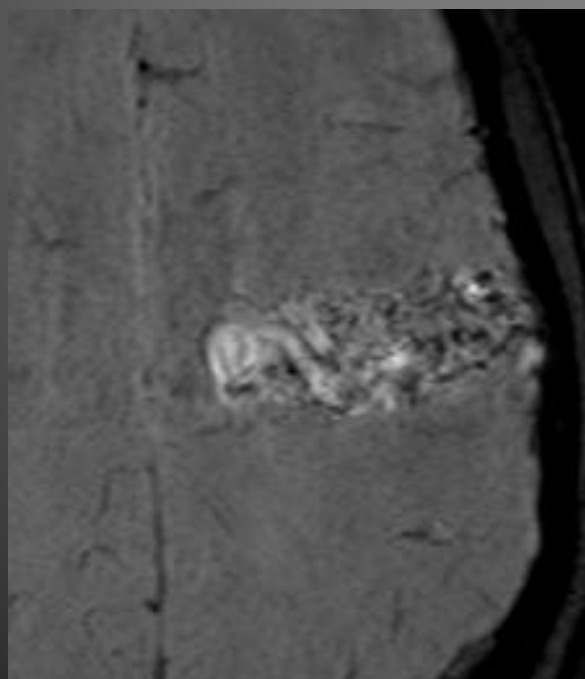
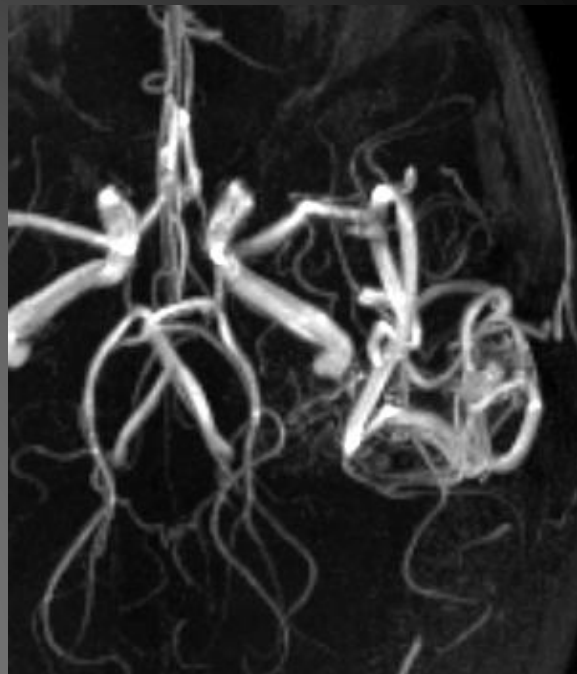
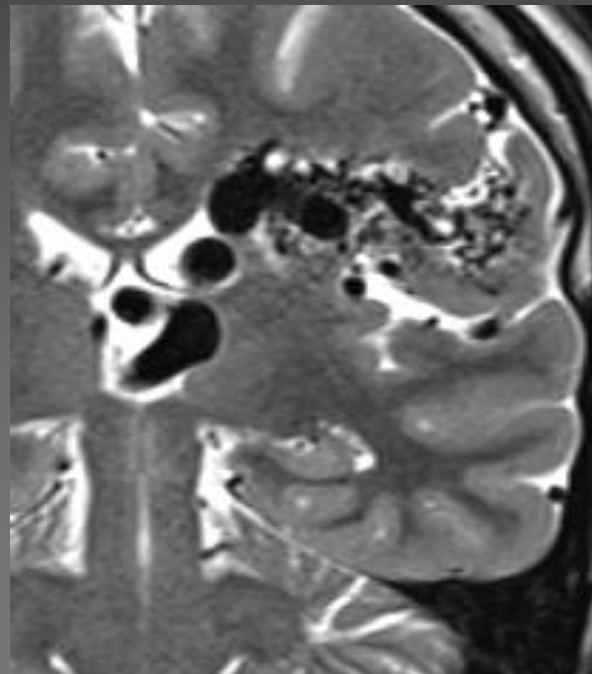
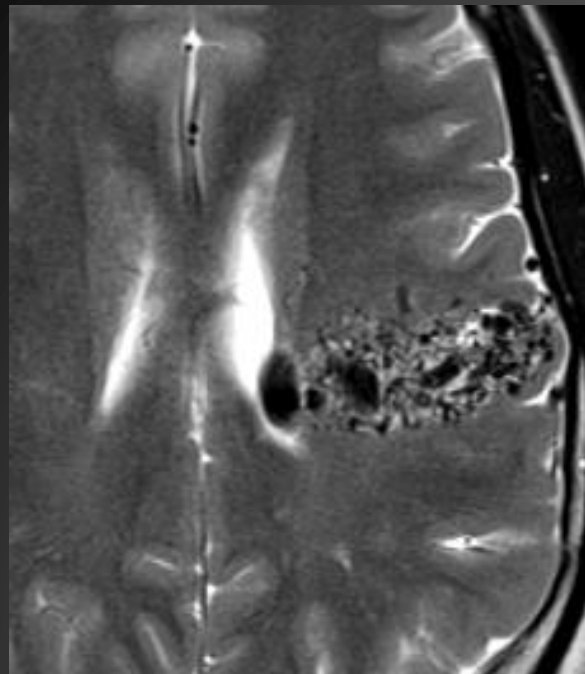
- Imaging Findings:
 - SWI- Diffuse white matter microhemorrhages
 - Patchy and confluent white matter signal abnormality and diffusion restriction

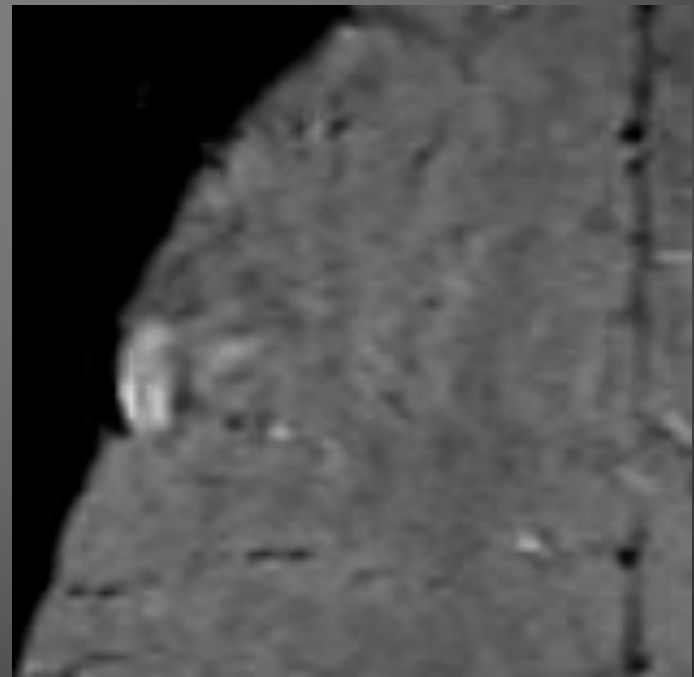
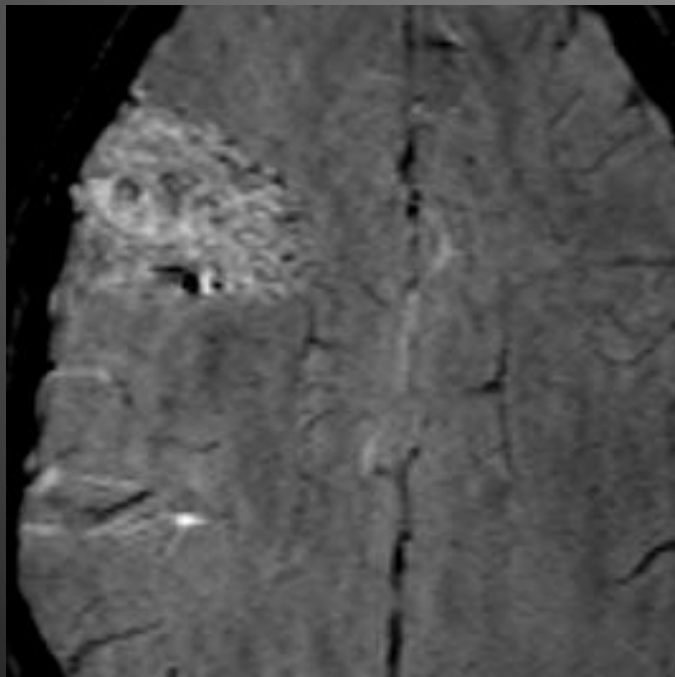
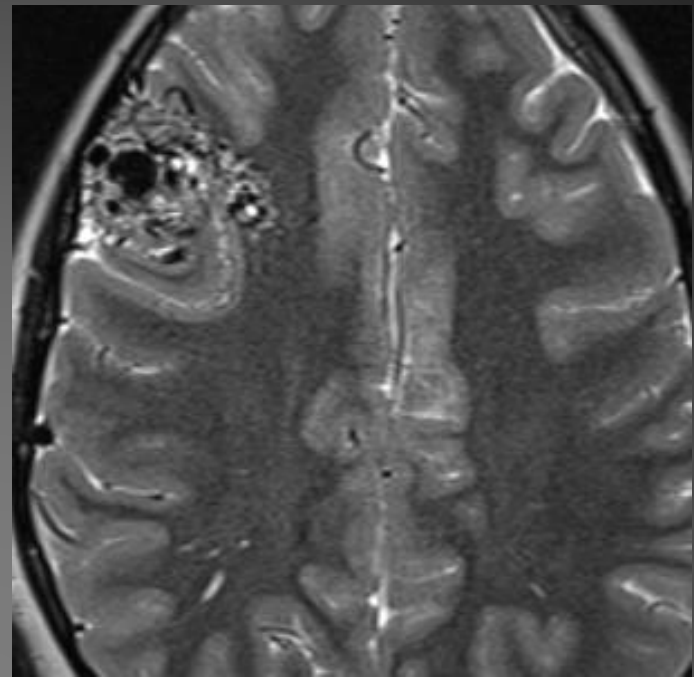
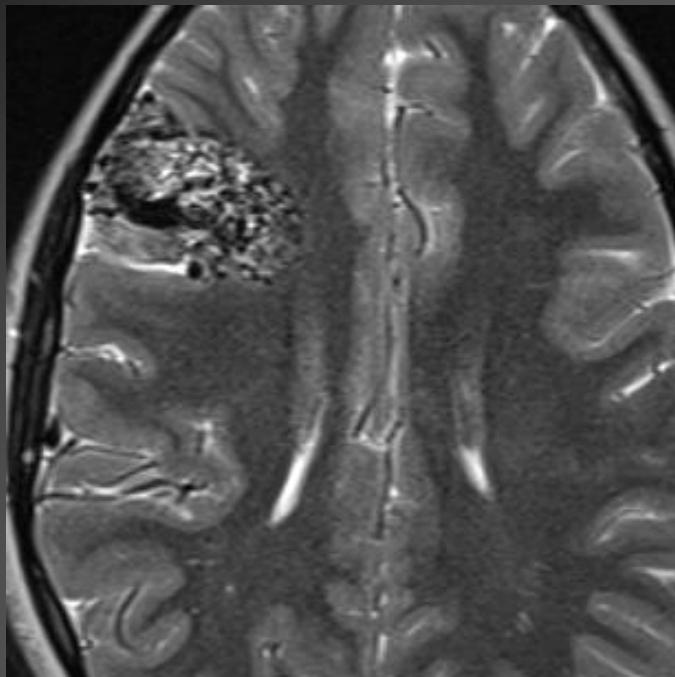


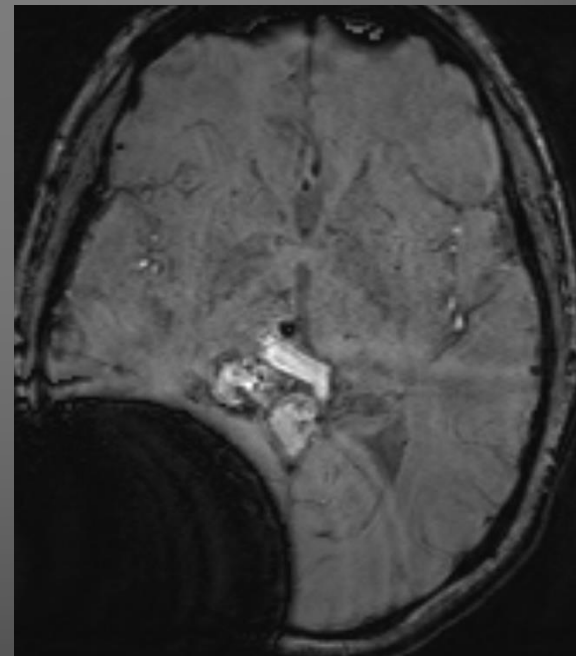
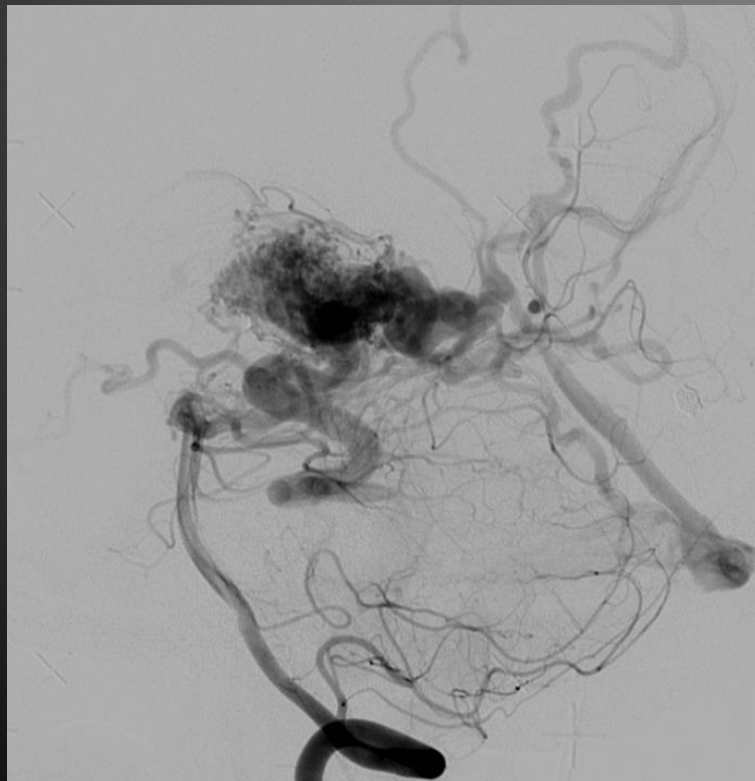
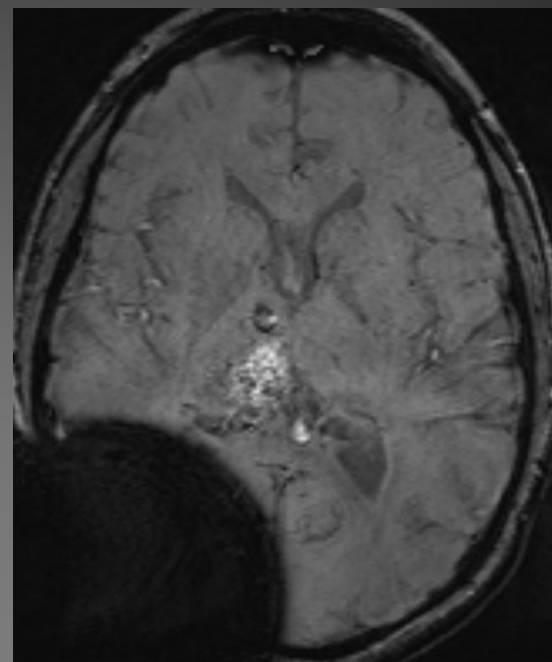
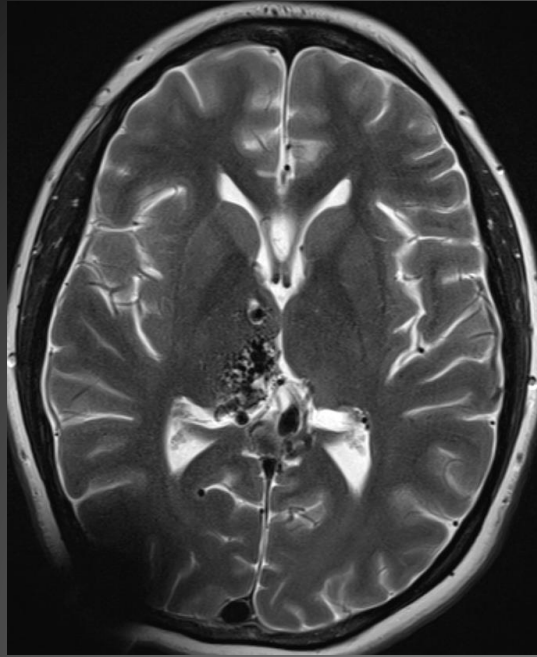
Susceptibility Weighted Imaging



- Very accurate in depicting AVM draining venous structures
 - Increased signal in the AVM draining veins
 - Dilated draining veins
- Micro AVM draining veins
- Better than TOF MRV
- Post-radiosurgery evaluation



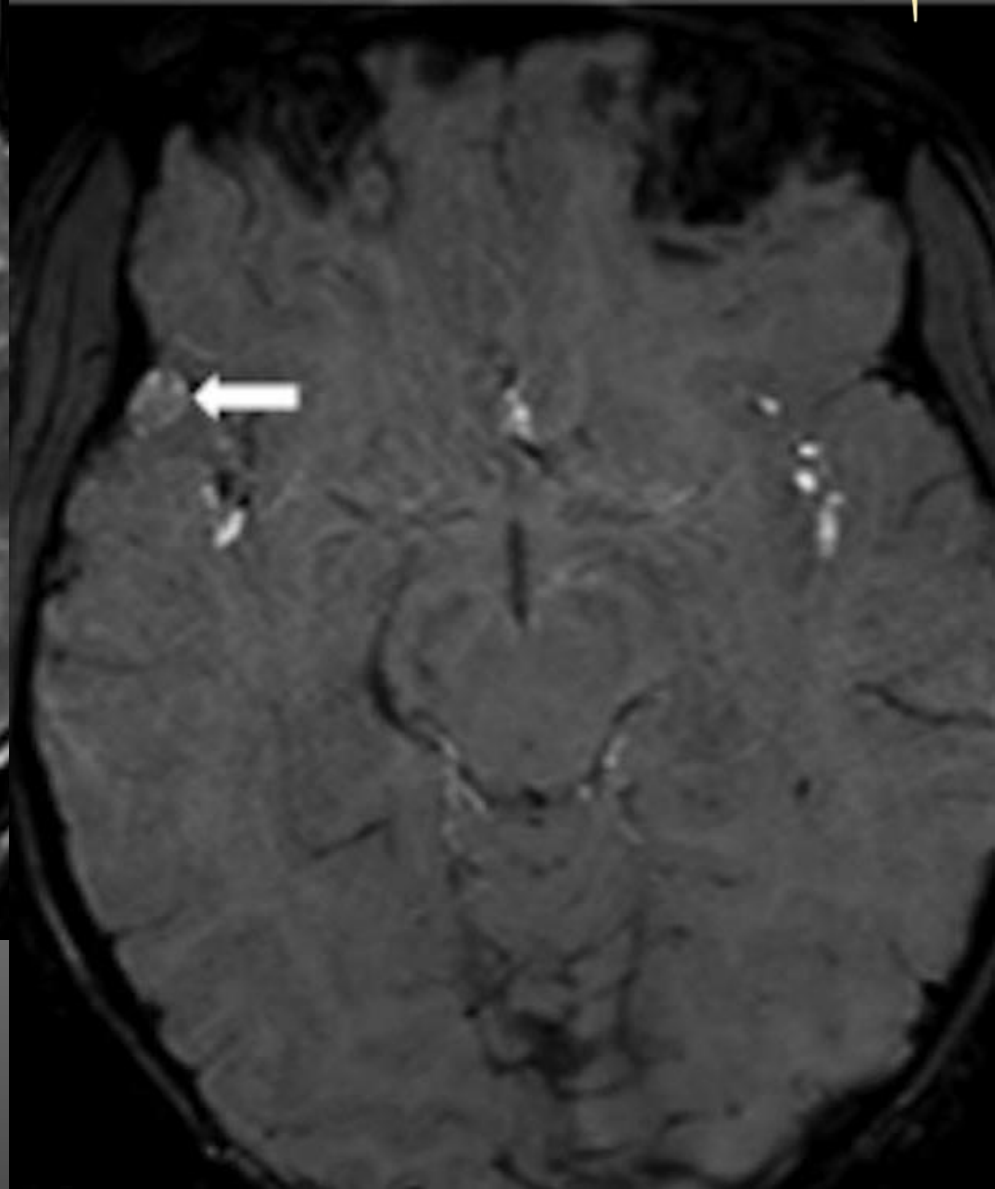
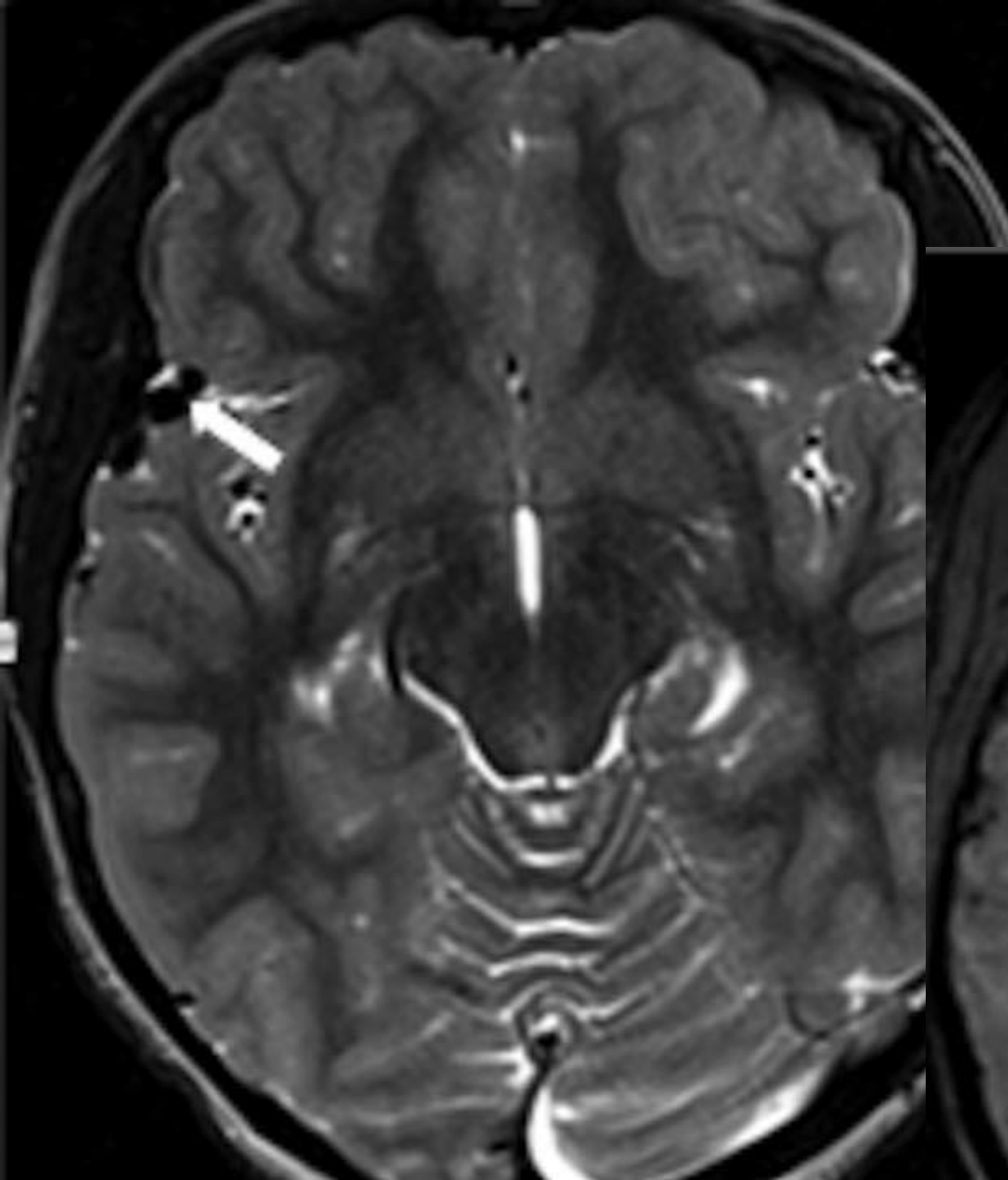






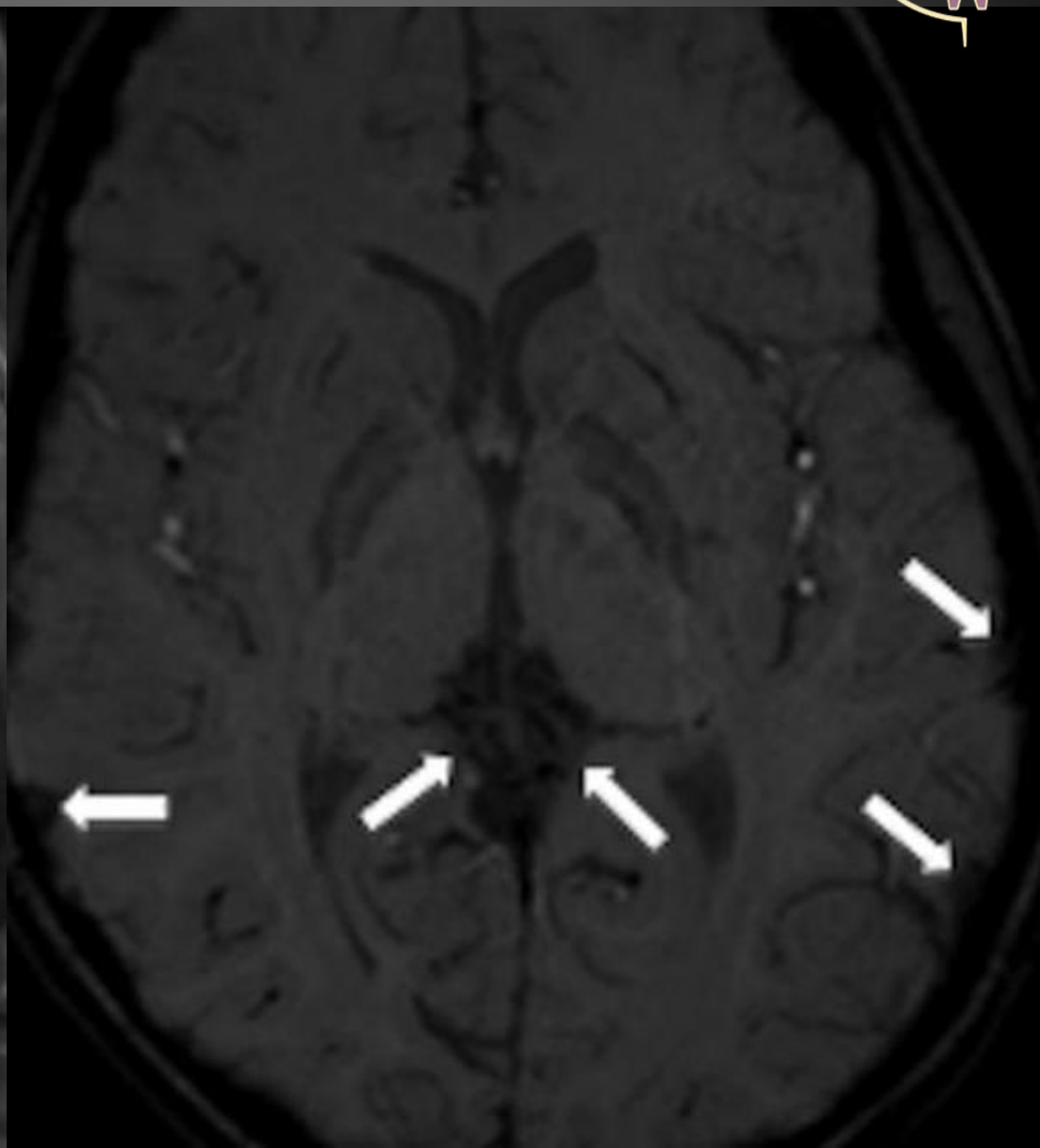
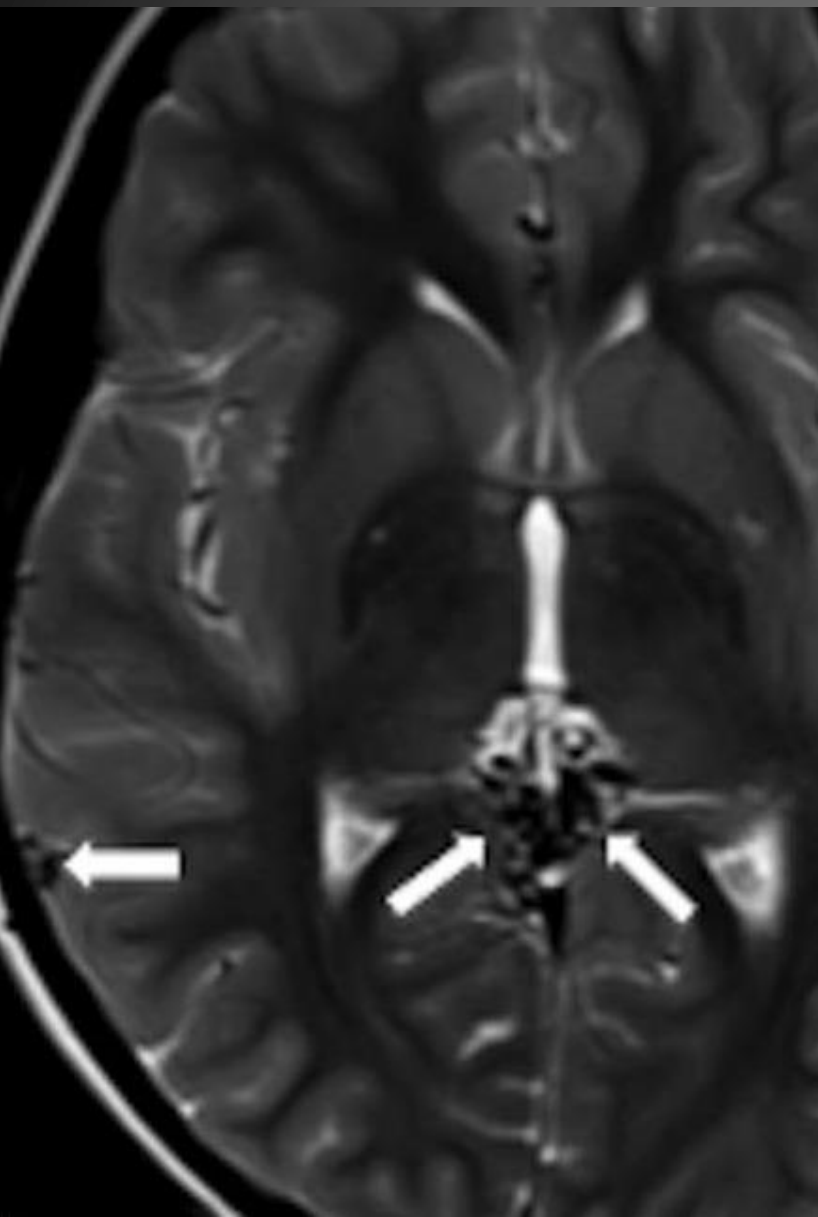
Post Radiosurgery on SWI

- Residual AVM draining veins
 - Hyperintense signal
- Ectatic residual veins after treatment
 - Dark signal
 - Increased susceptibility



Status post radiosurgery

Post Radiosurgery on SWI

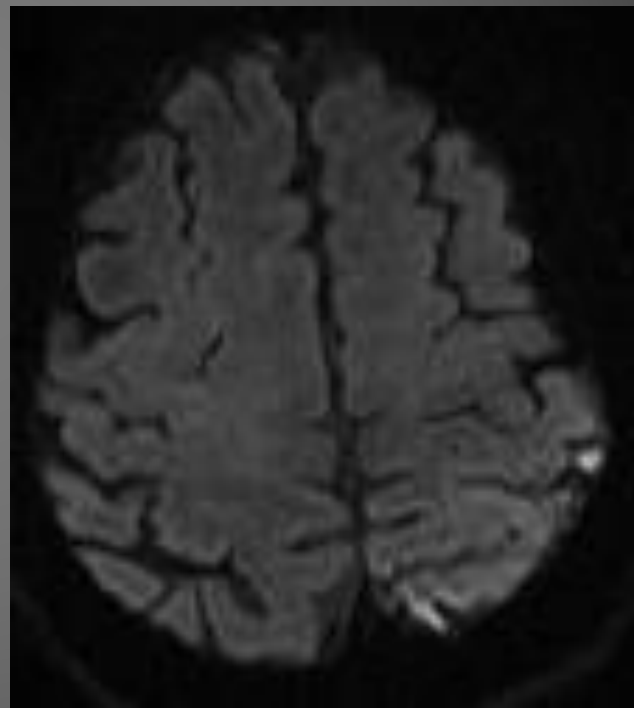
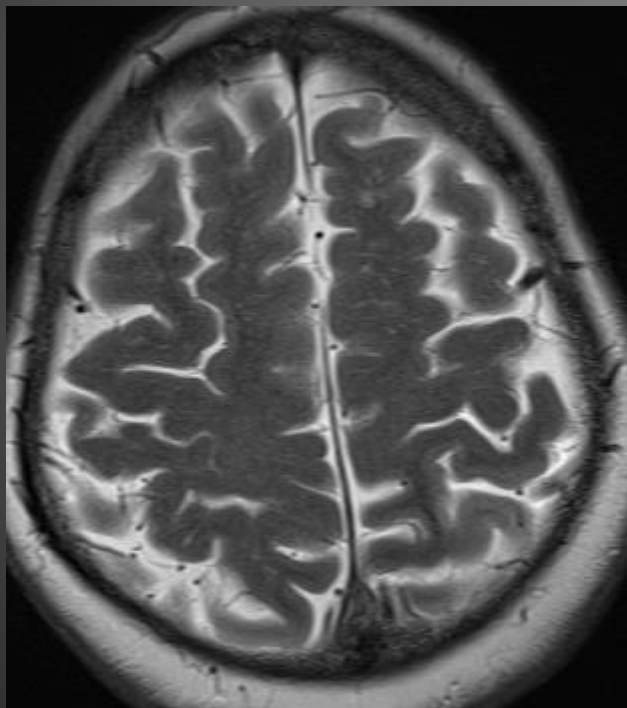


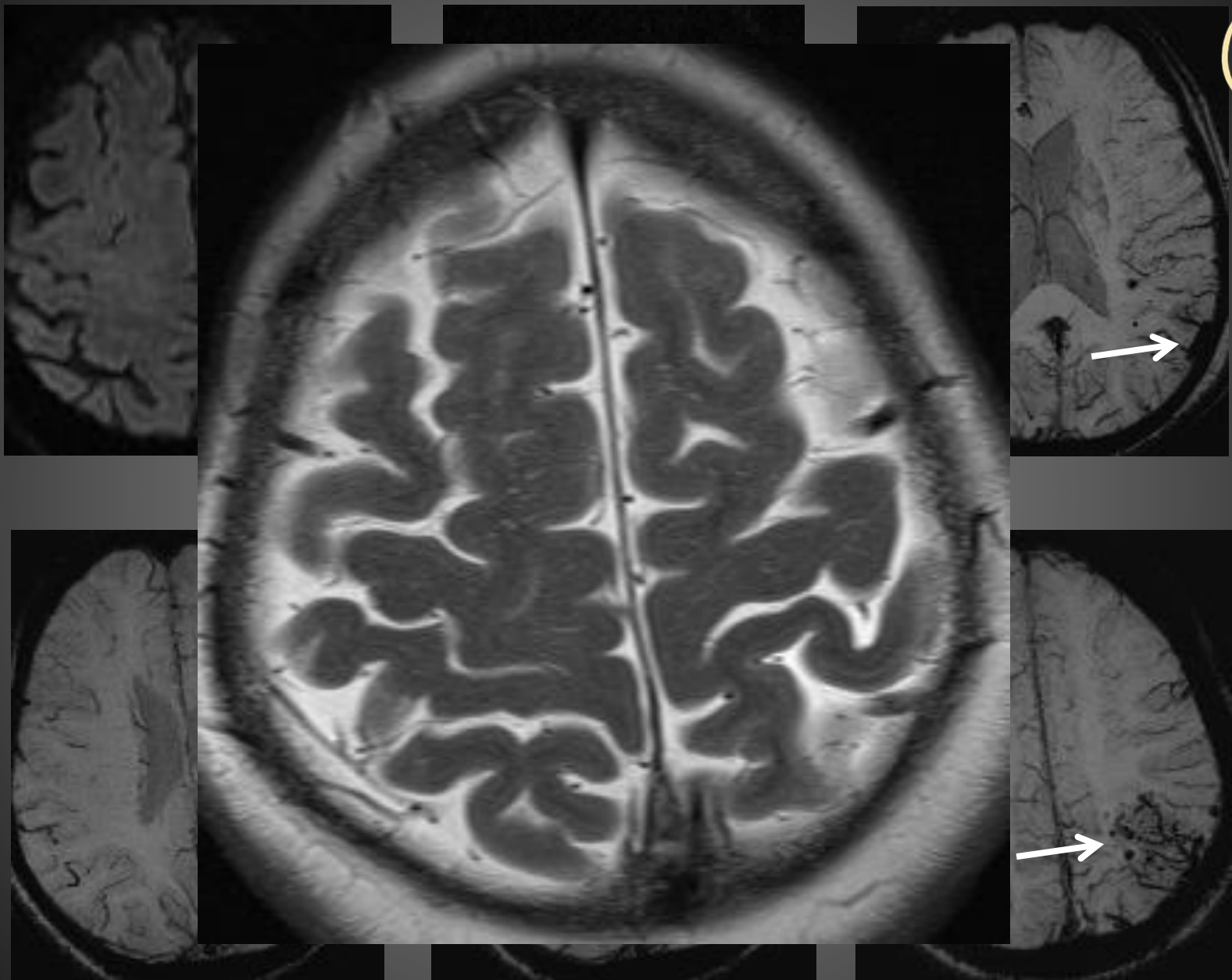


Value of SWI

- Post-stereotactic radiosurgery
 - Ectatic veins versus residual shunting
- Depiction of draining veins
- Improved detection of micro AVM's over conventional MRI and TOF MRA

Depiction of Venous Abnormalities



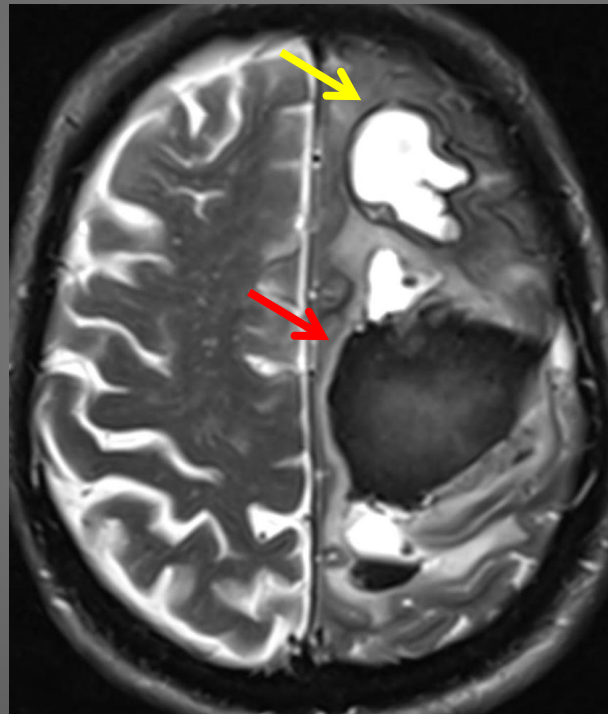


Cortical Vein Thrombosis with Venous congestion and parenchymal hemorrhage

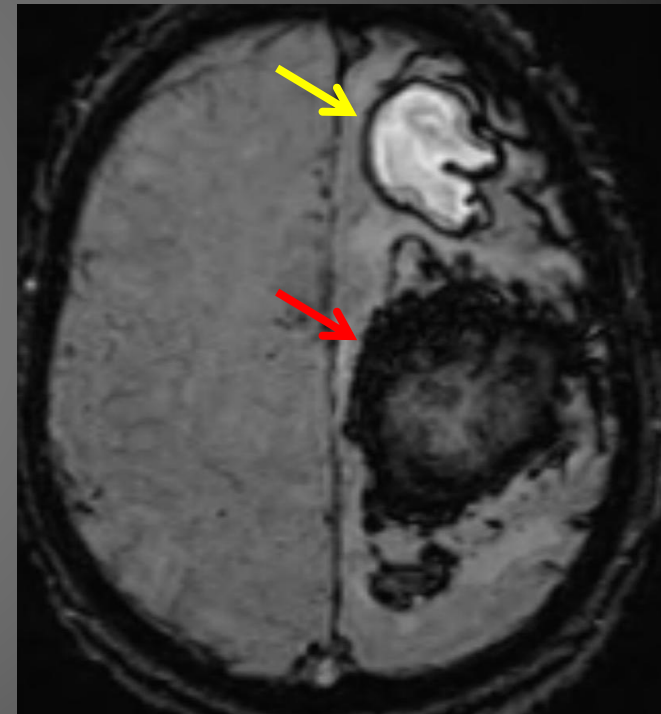


- SWI can depict cortical vein thrombosis better than MRV and T2-weighted techniques

Differential Susceptibility



T2

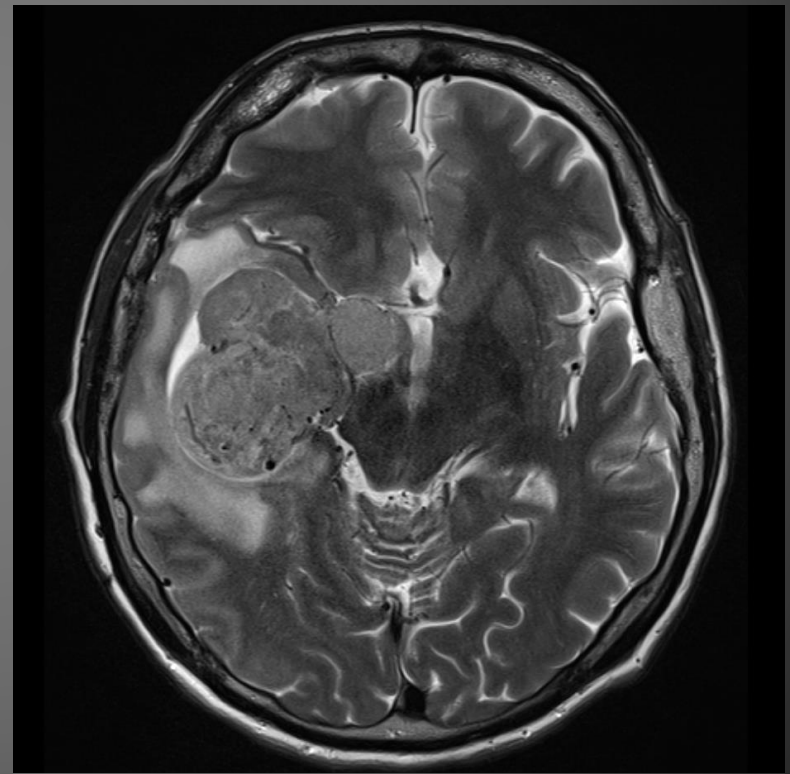
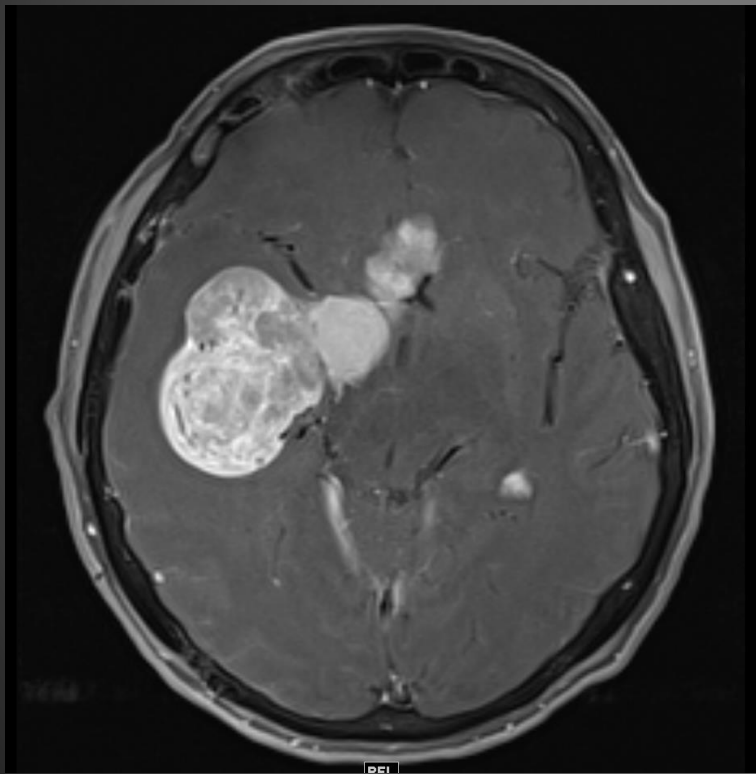


SWI

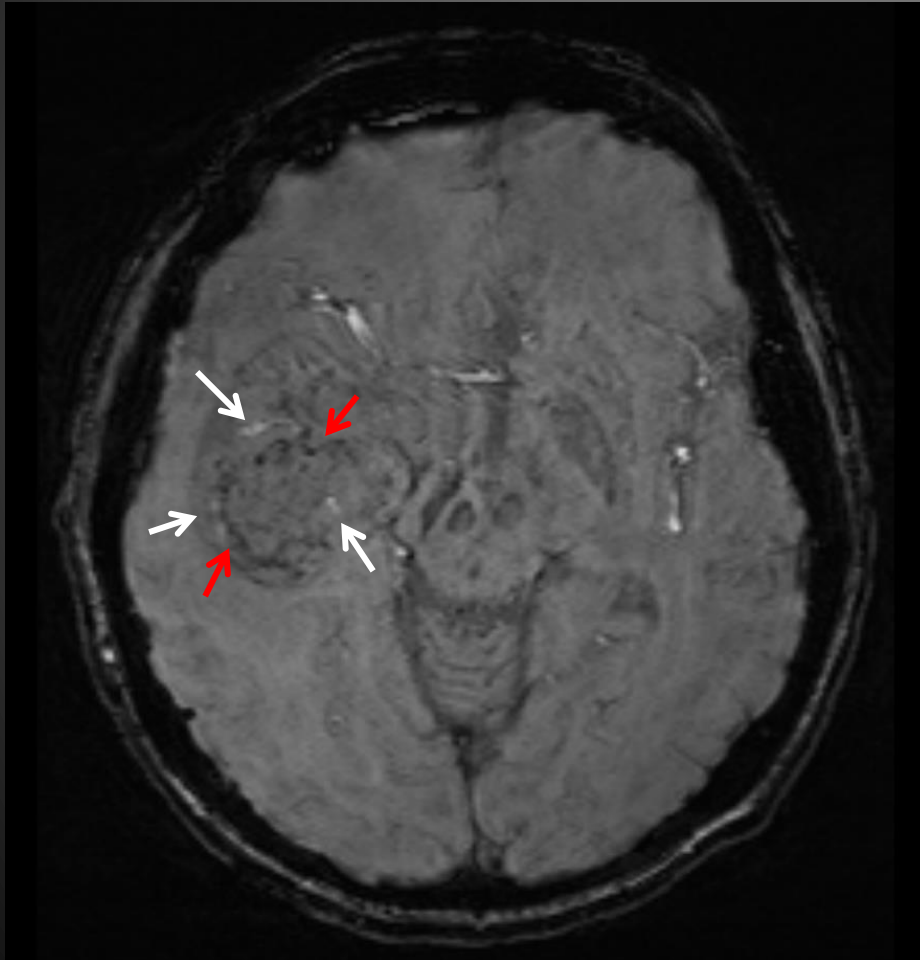
Extracellular methemoglobin

Deoxyhemoglobin

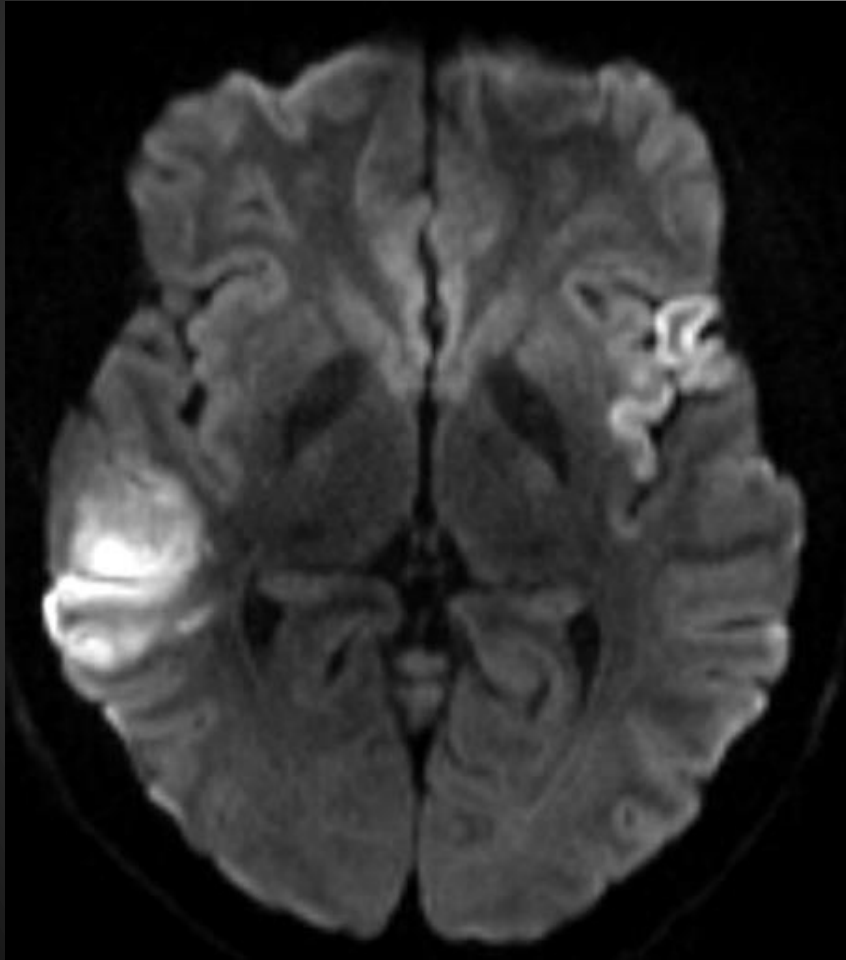
Skull Base Meningioma, Preop evaluation



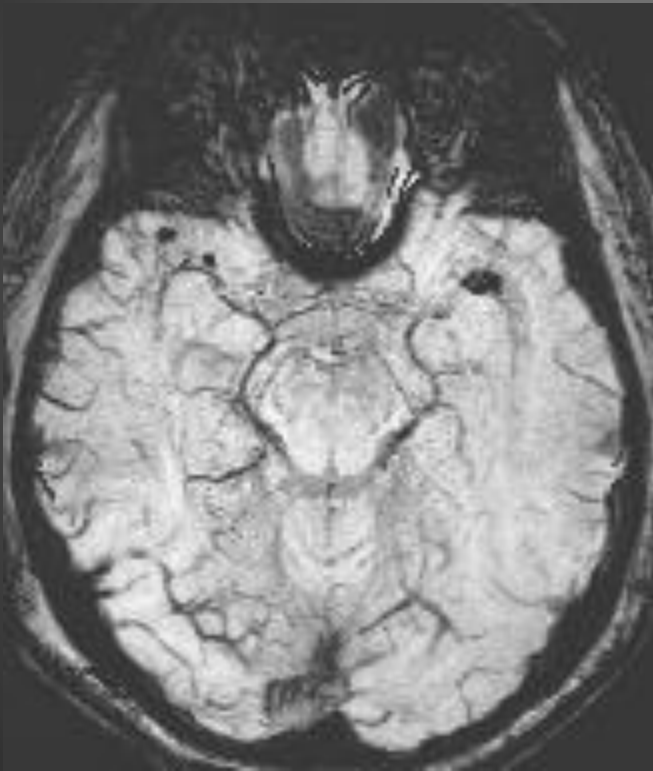
Tumor Vascularity



Varicella Vasculitis

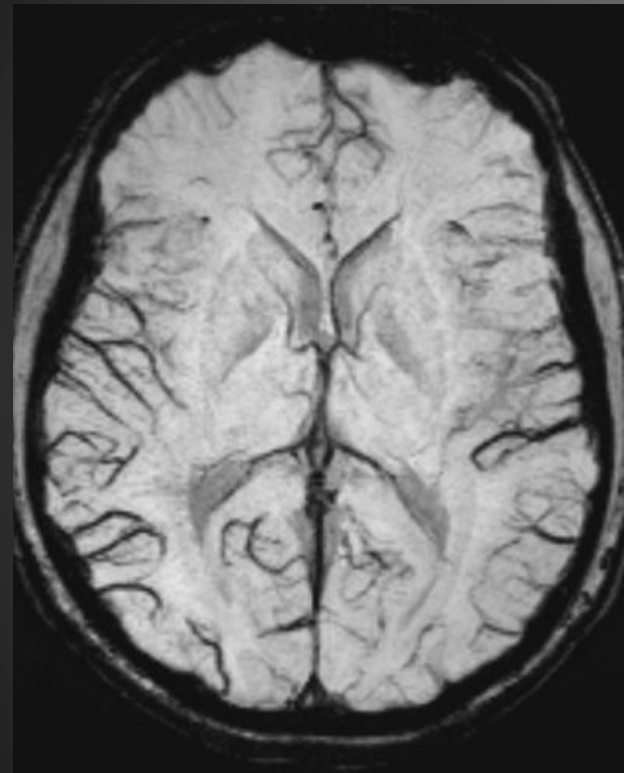


Susceptibility Vessel Sign

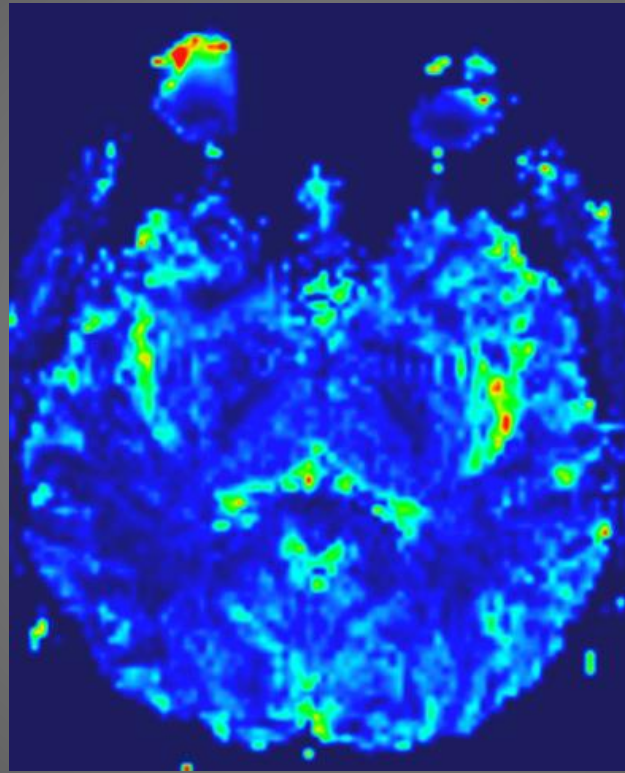


Vascular thrombosis depicted by susceptibility vessel sign.

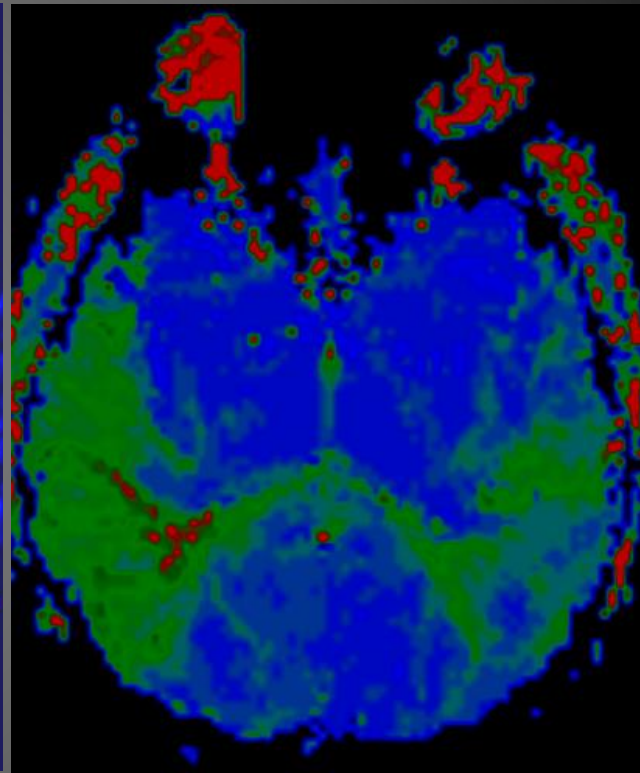
Perfusion Characteristics



MinP



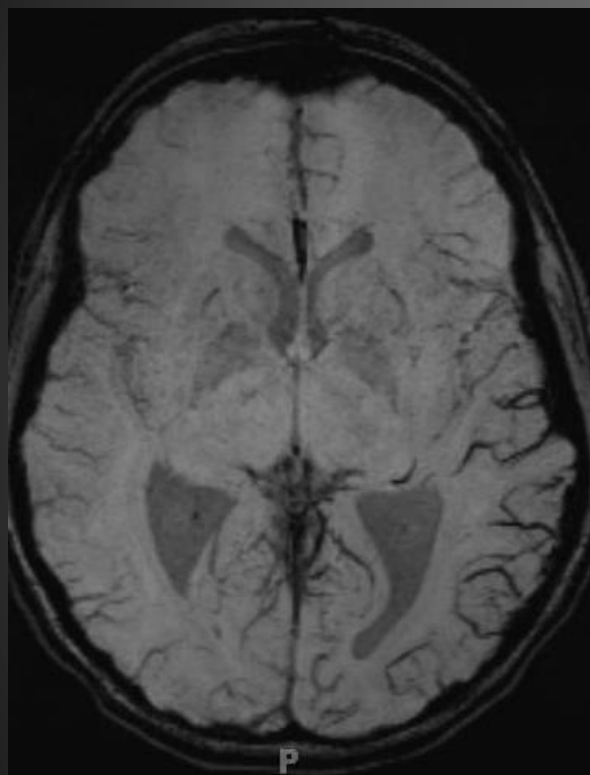
CBV map



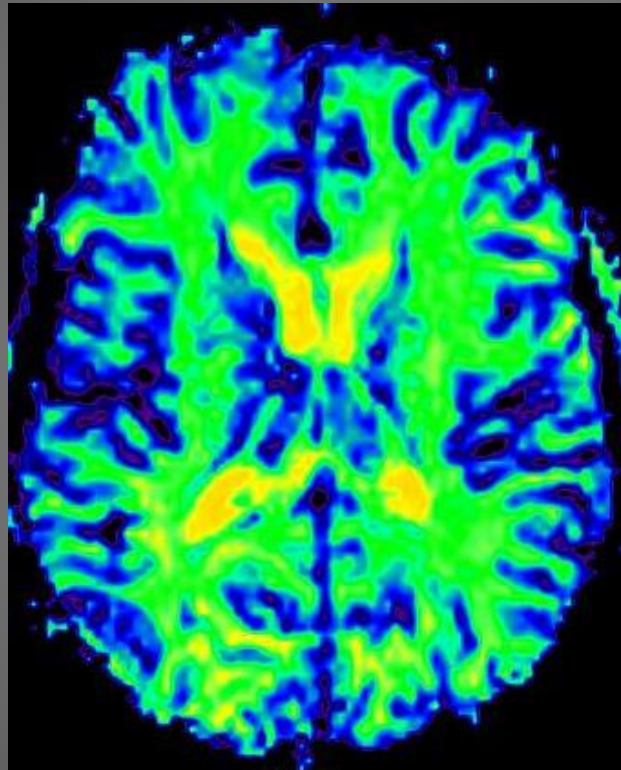
TTP map

SWI serves as a functional transit time map.

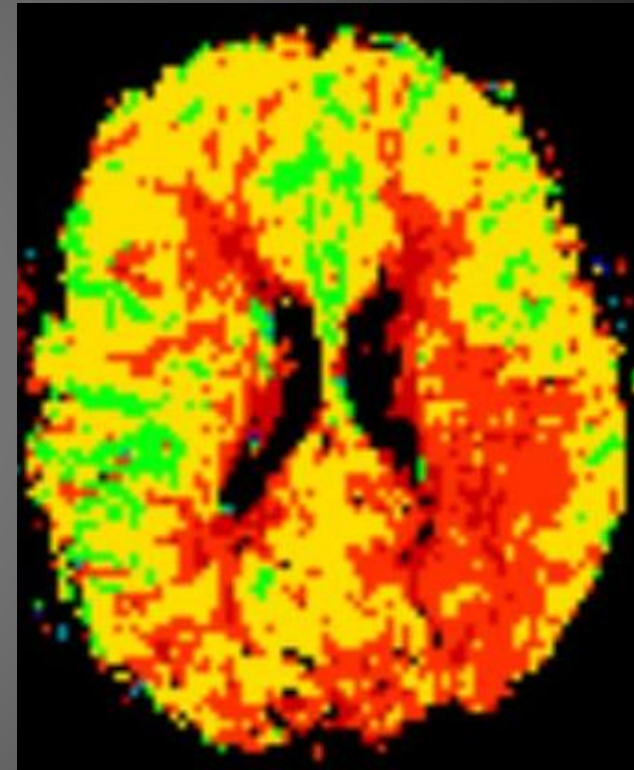
Perfusion Characteristics



MinP



CBV map



TTP map

Migraine Angiopathy

Migraine Angiopathy



Mild L MCA vasospasm

Summary

- SWI more sensitive to microhemorrhages
- Differential susceptibility
 - Indicate hemorrhage vs. calcification
 - Depict venous drainage in high flow vascular malformations
 - Perfusion data
 - Blooming of susceptibility helpful in detecting cortical vein and sinus thrombosis when other techniques may fail