Susceptibility artifacts at MRI

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Artifacts in MRI

• **Strength of MRI is weakness of MRI**

• **Appearance depends on many factors:**
  – T1, T2, PD, Flow, motion, susceptibility, chemical shift, diffusion, mag transfer, saturation effects, magic angle…

• **These many factors we exploit to detect pathology, but result in multiple artifacts**
Artifacts in MRI

• Every study in MRI contains imaging artifacts

• Discuss a small subset: artifacts due to field inhomogeneity (susceptibility)
40 yo old R hand numb
Gado fat sat GRE
40 yo old R hand numb
Gado FS GRE
40 yo old R hand numb
Gado fat sat GRE
Gado MRA next day. No fat sat
Susceptibility

• Def: Distortion of the magnetic field due to placement of materials in the magnet

• Create uniform magnetic field within 1ppm. 1.5 T: 64,000,000 Hz +/- 32Hz

• Patient distorts field especially at metal, edge of magnet bore, air soft tissue interfaces (worse: complex anatomy)
Metal increases field. Soft tissues decrease field. Distortion of field is often complex.
Inadvertent water saturation

- Fat saturation
- RF pulse at fat frequency

220 Hz

Frequency

Fat: 63000880
Water: 640000000

Inhomogeneous fat sat is bad
Inadvertent water sat is disaster

- If fat sat fails or is inhomogeneous: MAKE SURE THERE IS NO WATER SAT
- If water sat occurs the images are useless
- If autoshim or manual tune does not correct
  - Remove fat sat
  - Use STIR instead of T2 fat sat
  - Use subtraction for pre post contrast
Metal artifact

- Magnetic field increased at/adjacent to metal
- Artifact due to three effects
  - Inhomogeneous fat saturation
  - Dephasing: Inhomogeneous magnetic field in voxel causes dephasing signal loss
  - Misregistration: Signal is displaced in the frequency direction due to distortion of frequency encoding gradient
Frequency varies across voxel resulting in dephasing signal loss during TE.

Metal increase field and thus frequency. Dephasing decreased: SE > FSE >> GRE
Short echo time. Small voxel
Double bandwidth Error in x direction is smaller

With frequency encode gradient

Signal in x locations in grey bar is incorrectly assigned to location corresponding to high field edge of the bar

Position in x (freq) direction

64MHz
GRE

SE PD TE 20

SE T1 TE 10
Swap freq
62 yo right hip pain
How to scan with metal

- **No fat sat:**
  - STIR for edema detection
  - Subtraction of pre from post contrast images
- **Fast spin echo** > **spin echo** > **gradient echo**
- **Minimize TE. Fast spin echo for long TE**
- **Maximize bandwidth!** Decreases misregistration. Decrease TE and echo space which decreases dephasing signal loss
How to scan with metal

• Swap phase and frequency if needed
• 1.5T better than 3T
• Smaller voxels decrease dephasing: thinner slices >> increase matrix, but decrease SNR
• If available, specialty metal sequences
Susceptability artifacts

- Understanding the mechanism
  - Recognize
  - Decrease