

SAM Practical Medical Physics  
TU-B-201-0

## IDENTIFYING IMAGE ARTIFACTS, THEIR CAUSES, AND HOW TO FIX THEM

AAPM Annual  
Meeting 2017

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### Abstract

- This course will teach the participant to identify common artifacts found clinically in MR, DR, CT, PET, to determine the causes of artifacts, and to make recommendations for how to resolve artifacts.

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### Learning Objectives

1. Identify common artifacts found clinically
2. Determine causes of various clinical artifacts
3. Describe how to resolve various clinical artifacts

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## Speakers

- ⦿ Robert Pooley – MRI
- ⦿ Beth Schueler - Digital Radiography
- ⦿ Jim Kofler - CT
- ⦿ Brad Kemp - PET

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Robert A. Pooley, Ph.D.  
Mayo Clinic Florida

## IDENTIFYING IMAGE ARTIFACTS, THEIR CAUSES, AND HOW TO FIX THEM: **MR**

AAPM Annual  
Meeting 2017

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## Outline: Artifact Identification, Cause, How to Fix

- ⦿ Motion / ghosting
- ⦿ Aliasing / wrap
- ⦿ Radiofrequency interference
- ⦿ Metal
- ⦿ Corduroy

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## Motion / Ghosting

- Identification:
  - May appear as repetition of "ghosts" across image, may be distinct or blurred depending on type of motion
  - Typically occurs in phase encoding direction
- Causes:
  - Patient motion, physiologic / involuntary, voluntary; equipment vibration / instability

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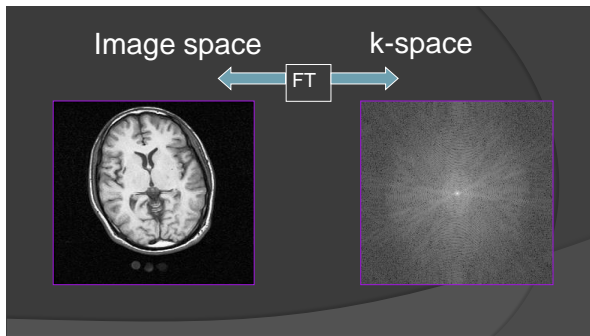
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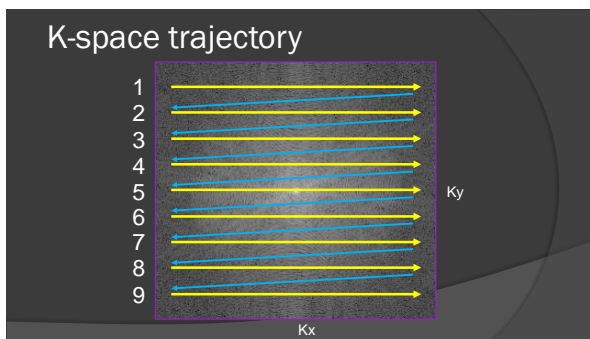
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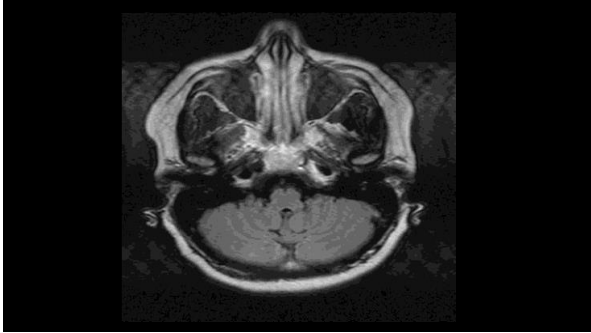
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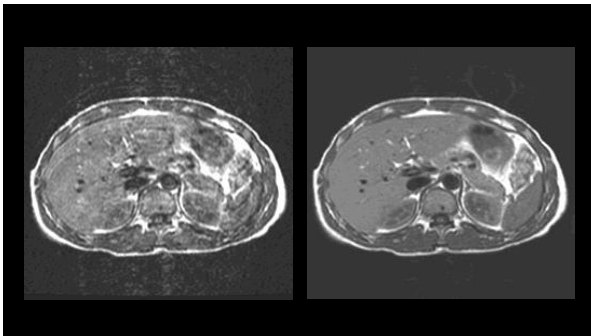
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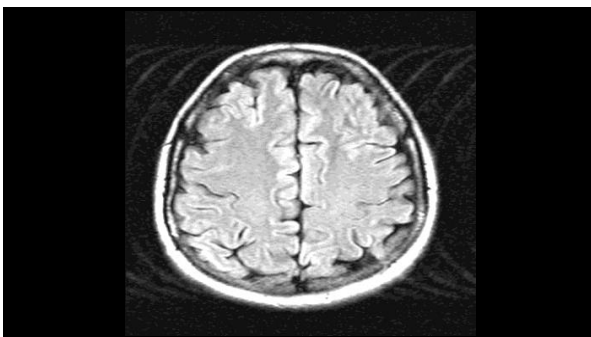
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## Propeller / Blade

- Reduce sensitivity to motion
- May be used for uncooperative patients

Pipe, Magn. Reson. Med. 1999; 42:963-969

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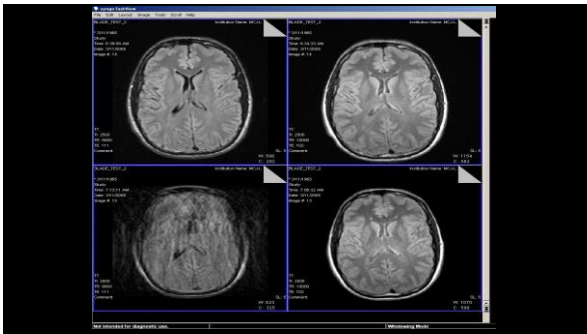
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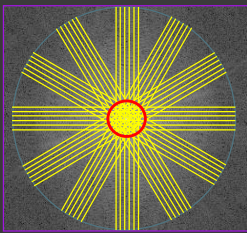
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## K-space



Propeller

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## Propeller / Blade

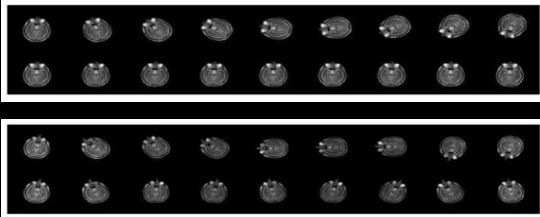


Image from Siemens Applications guide

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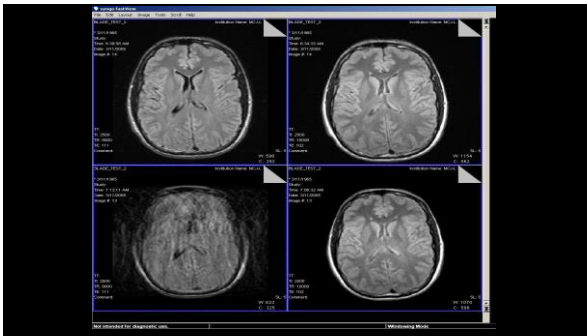
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## Motion / ghosting

- How to fix:
  - Remind patient to hold still, make patient more comfortable, decrease scan time, consider sedation
  - Use respiratory triggering / navigator pulses, motion correction, breath-hold options when available
  - Implement Propeller / Blade sequence options
  - Address equipment problems, test with phantom, test with cold-head off
  - Swap phase and frequency if artifact obscures pathology

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## Aliasing / wrap

- Identification:
  - Patient anatomy appears in incorrect locations
- Causes:
  - Insufficient sampling
  - Small FOV with anatomy (signal) outside FOV

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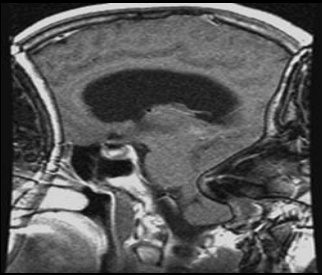
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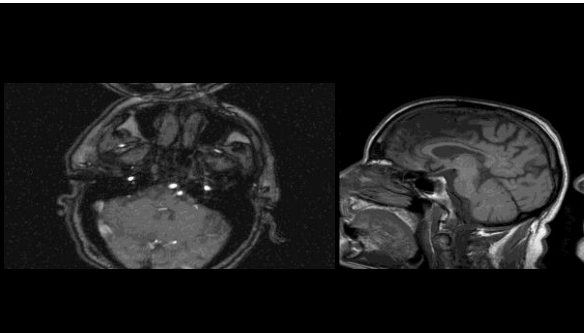
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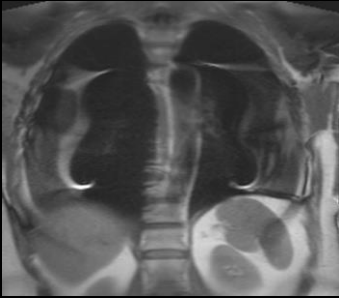
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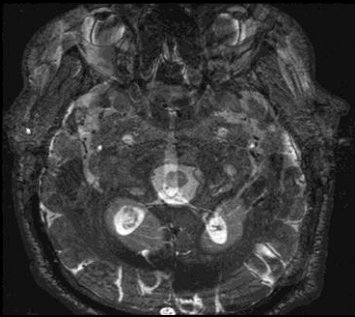
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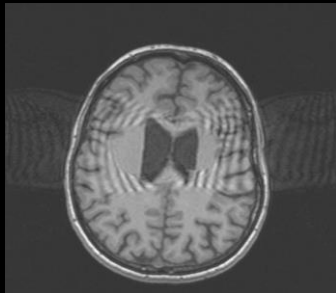
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## Aliasing / wrap

- ⦿ How to fix:
  - Increase FOV
  - Increase over-sampling in phase encoding and / or slice directions (for 3D)
  - Use saturation bands for anatomy outside FOV
  - Turn off coils outside imaging volume

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## RF Interference / Zippers

- ⦿ Identification:
  - Typically appears as single or multiple lines ("zipper") in the phase encoding direction
- ⦿ Causes:
  - Unexpected radiofrequency signal from equipment inside room, or outside room with poor RF shielding

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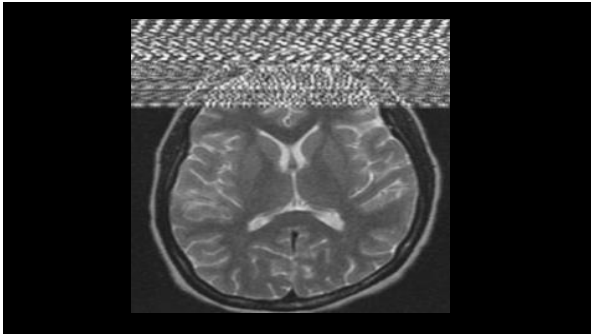
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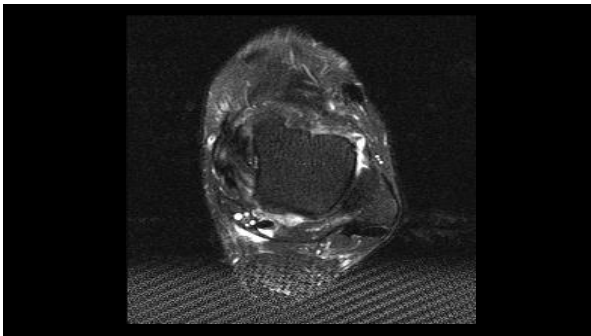
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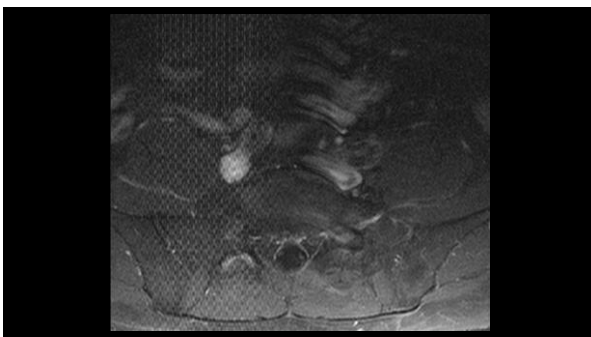
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## RF Interference / Zippers

- How to fix:
  - Identify source, replace electronic components generating unwanted RF signal
  - Check integrity of RF shielding, clean RF door threshold and RF fingers / plates

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## Metal

- Identification:
  - Signal void, often with adjacent very bright signal
  - Geometric distortion
- Causes:
  - Magnetic susceptibility, induced eddy currents, spin dephasing

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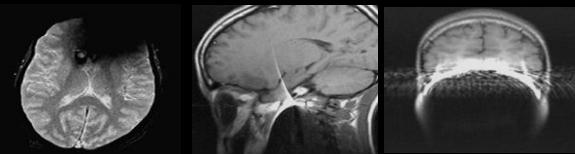
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## Metal




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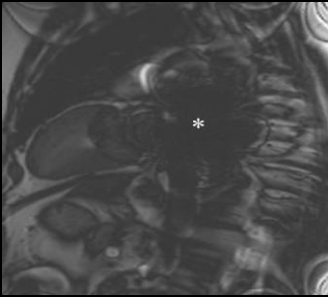
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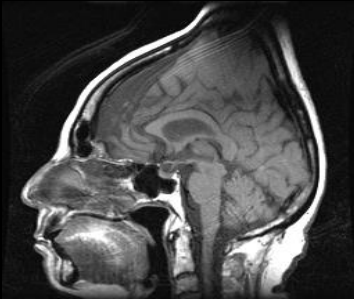
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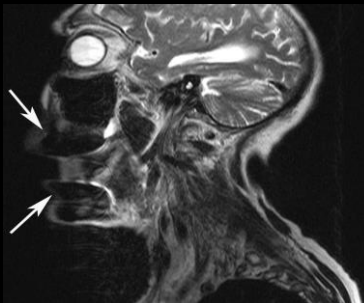
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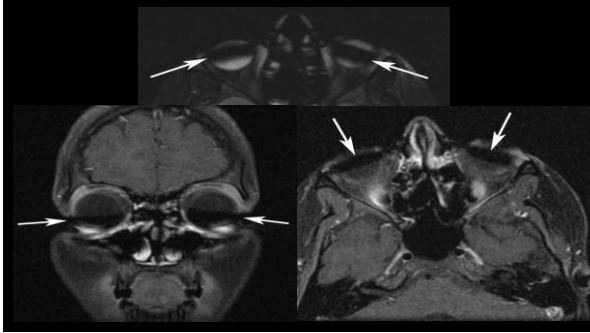
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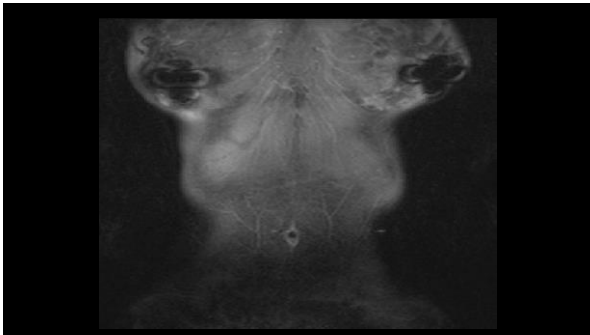
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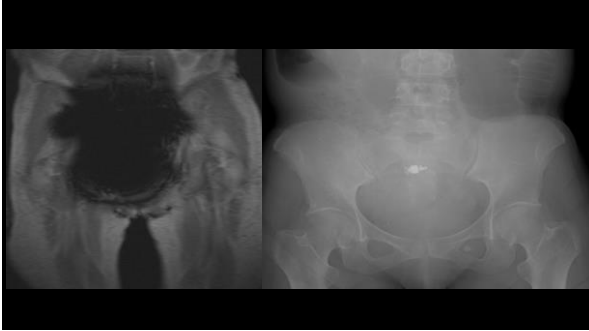
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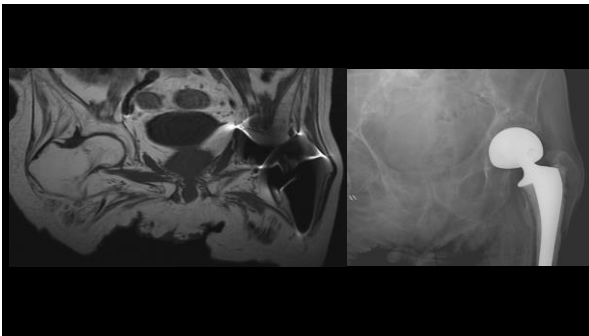
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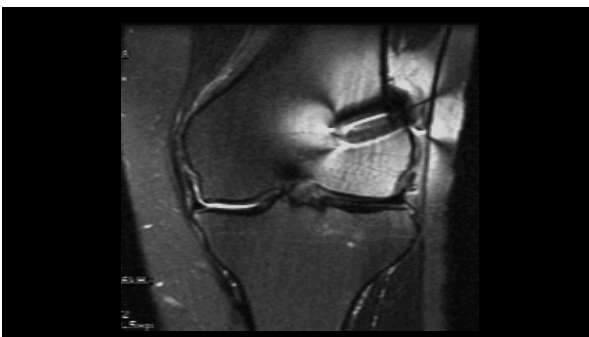
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## Metal

- How to fix / reduce:
  - Properly screen patient, remove any metal that can be removed
  - Turbo spin echo and spin echo sequences reduce artifact compared to gradient echo
  - Decrease TE and echo spacing; increase bandwidth and resolution in frequency encoding direction
  - Swap phase and frequency to modify shape

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## Corduroy

- Identification:
  - Pattern of regularly spaced lines extending across image
  - Can occur at different spatial frequencies and different angles
  - Multiple sets can combine to appear as a cross-hatch pattern
- Causes:
  - Spike(s) in k-space

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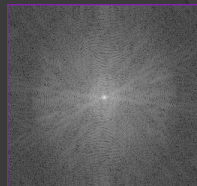
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Image space      k-space




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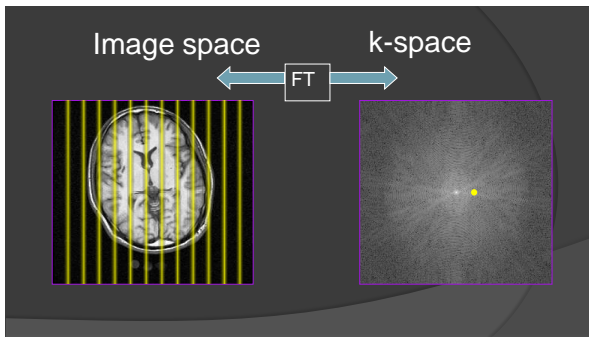
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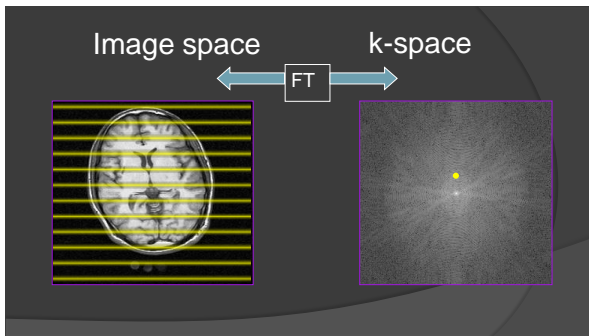
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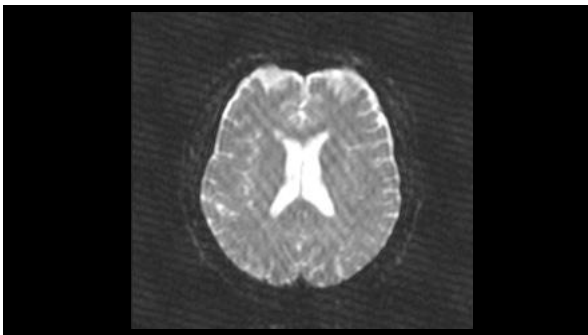
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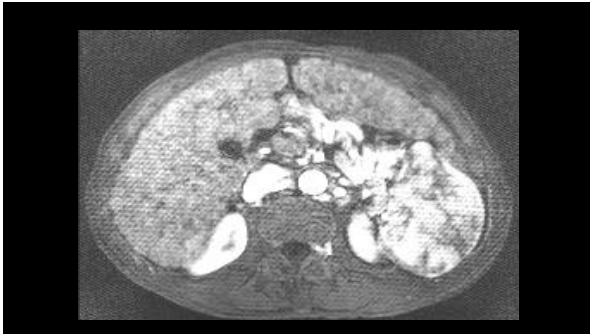
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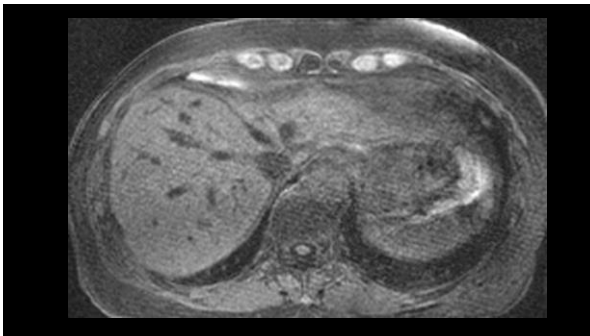
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## Corduroy

- How to fix:
  - Confirm room humidity in specification
  - Perform scanner spike check
  - Attempt to localize source if in room
  - Call Service

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## Bonus Artifact:



Reddit: "Camera Malfunction"  
Courtesy Catherine Sturchio

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## Suggested Reading

- DW McRobbie, EA Moore, MJ Graves, MR Prince, "MRI: From Picture to Proton," 2<sup>nd</sup> edition, Cambridge University Press
- Dietrich, "Artifacts in 3-Tesla MRI: Physical background and reduction strategies" EJR 2008 65(1) 29-35

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Thank You  
Mayo Clinic Florida




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## Flow

- Identification:
  - Ghosting, appears as repetition (phase encoding direction) of blood
- Causes:
  - Velocity induced phase effects

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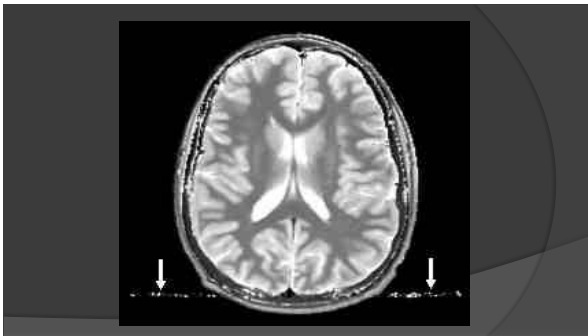
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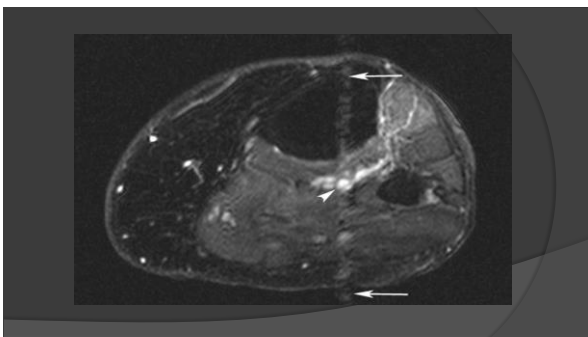
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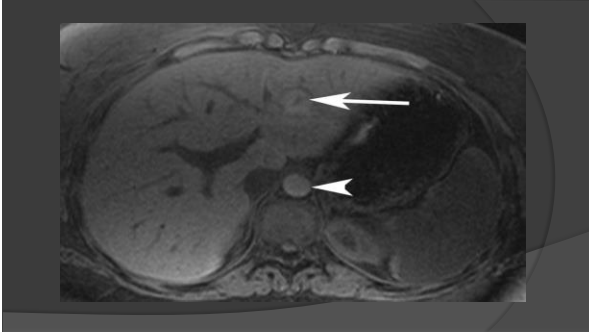
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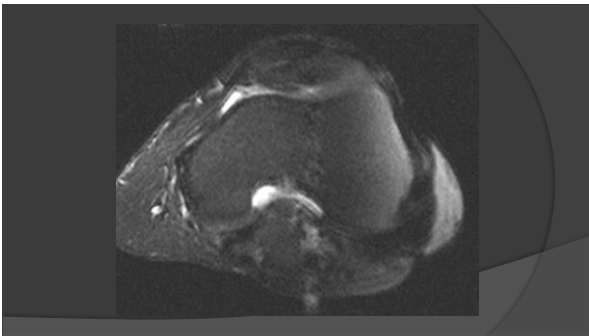
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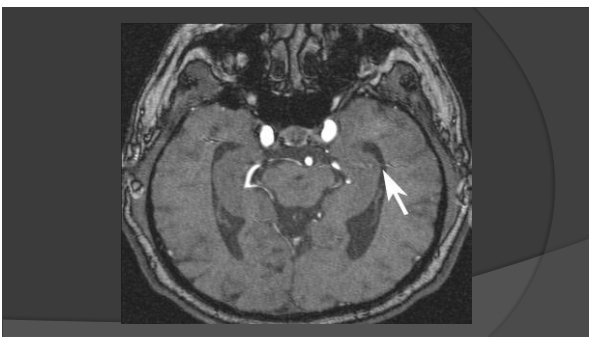
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## Flow

- How to fix:
  - Gradient moment nulling / flow compensation
  - Spatial saturation bands
  - Swap phase and frequency if artifact mimics pathology

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