

Volume 1, Number 11 – December 18, 2007

## **RADIOLOGY: THE ADVANCED MODALITIES** *Magnetic Resonance Imaging (MRI) – Part 2 of 2*

### **PULSES**

#### **Pulsing Sequences**

Innumerable pulsing sequences can be applied. By varying the RF pulses (the “spin”), we can create different sequences, such as:

- A T1-weighted spin echo sequence, which accentuates substances that contain fat; or
- A T2-weighted spin echo sequence, which accentuates substances that contain water.

Similarly, the gradient magnets can be turned on and off to create a gradient echo sequence, which is iron- and calcium-sensitive. One type of gradient sequence, a diffusion-weighted sequence, accentuates differences in the motion of water. This is very useful in detecting acute strokes in the brain.

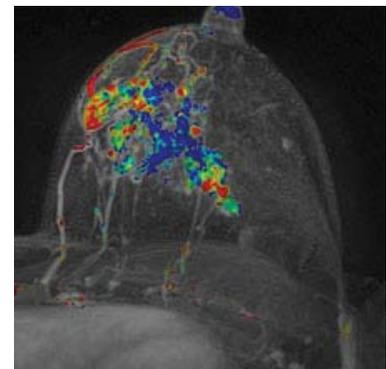
### **CONTRAST**

#### **Gadolinium Contrast**

Gadolinium (a rare earth usually coupled to a salt and a chelator) is an intravenous contrast agent used in MRI. Intravenous contrast is used in MRI for the same reason as in CT: It is injected into a blood vessel in order to see the blood vessels better, and to see tissues that have varying amounts of blood supply. Gadolinium is an excellent angiogenesis marker – that is, it’s good for measuring tumor blood flow and vessel proliferation.

#### **Angiogenesis Tumor Markers on MR**

- **Wash-In Slope** (Permeable Map)
- **Wash-Out** (Tumor Extraction Fraction)
  - Vessel Dysplasia
- **Area under the Curve**
  - New Vessel Proliferation
- **Time to Appearance**
- **Signal Enhancement Ratio**  
(Behavior Relative to Normal Tissue)



*Contrast-enhanced MRI of breast showing multiple lesions in the left breast.*

In most patients, gadolinium is extremely safe; the incidence of serious reactions is less than 1%. However, nephrogenic systemic fibrosis, a serious complication of gadolinium, has been discovered recently in patients with kidney failure. This is a very rare but serious disease that causes fibrosis of the skin, eyes, and internal organs and can lead to death. Thus, gadolinium should be given with caution to patients with mild renal failure, and should not be administered to patients with very severe renal failure unless it is absolutely necessary.

## MRI TERMS

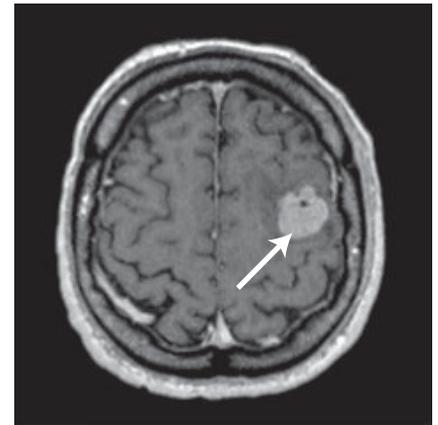
### Commonly Used MRI Terms

- **Signal:** The waves that are emitted from the body after the RF pulse are used to create the signal, or useful information for the image.
- **Intensity:** How bright the tissues appear on an image.
- **Gradient:** The part of the magnet that varies the magnetic field slightly in different areas, allowing the computer to separate the images in different parts of the body.
- **Coil:** The part of the MRI machine that is laid directly on the body part of interest and creates the RF excitation pulse; may function as signal detector pulse.
- **T1-weighting:** A procedure that accentuates body fat.
- **T2-weighting:** A procedure that accentuates water in the body.
- **Tesla:** A measure of the strength of a magnetic field.

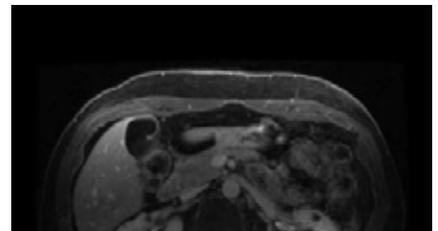
## MRI USES

### Common Uses of MRI

- **Brain**
  - Provides detailed anatomy
  - Evaluation of masses/tumors
  - Evaluation for stroke
  - Evaluation for infection
  - Evaluation for bleeding
  - Evaluation for congenital anomalies (birth defects)
- **Joints**
  - Allows very detailed view of ligaments, tendons, and muscles to look for injuries and masses
  - Excellent way to grade arthritis, and to measure and characterize synovium and cartilage
  - Excellent for looking at bone marrow – particularly useful with bone tumors
  - Allows detailed evaluation of spinal disease; can see the discs and spinal cord in detail
- **Abdomen/pelvis**
  - Provides good anatomic detail
  - Used often in children, because of the lack of radiation
  - Used to look at the ovaries and uterus, because of the level of anatomic detail and lack of radiation



*Contrast-enhanced MRI showing mass in the brain's left frontal lobe.*



– Assessment of venous occlusion (inferior vena cava, portal, and other veins)

- **Breast**

- Excellent for detection of breast cancers than cannot be seen on mammograms

- Can often differentiate benign from malignant masses in the breast

- Can delineate the extent of a known cancer, and look for additional sites of cancer that can't be seen on mammogram

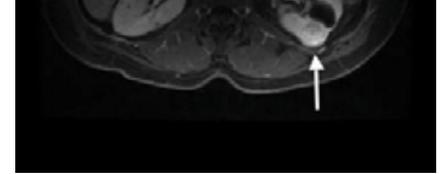
- Used to see how a cancer responds to treatment

- Can measure angiogenesis (vessel proliferation) of breast and other cancers

- **Heart**

- The definitive noninvasive test to detect and map areas of low blood flow or tissue death after a heart attack

- Evaluates for congenital abnormalities



*Contrast-enhanced MRI showing renal cell carcinoma along the posterior left kidney (arrow).*

**PROS  
AND  
CONS**

## Advantages and Disadvantages of MRI

### Advantages

- No radiation exposure
- Excellent differentiation of substances in the brain that cannot be differentiated on CT
- Best-detailed view of soft tissues of the arms and legs
- Detailed and accurate evaluation of breast cancers
- Best medullary bone evaluator

### Disadvantages

- Relatively expensive and time-consuming
- Spatial resolution not as good as CT
- Requires experienced reader
- Not good for evaluation of calcium bone cortex (x-rays and CT are better)
- Less effective than CT at seeing air (lungs) or gas (as in infection or bowel perforation)

## NEXT ISSUE (JANUARY 2008): OTHER IMAGING MODALITIES



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