LECTURE 14: MRI/FMRI SAFETY

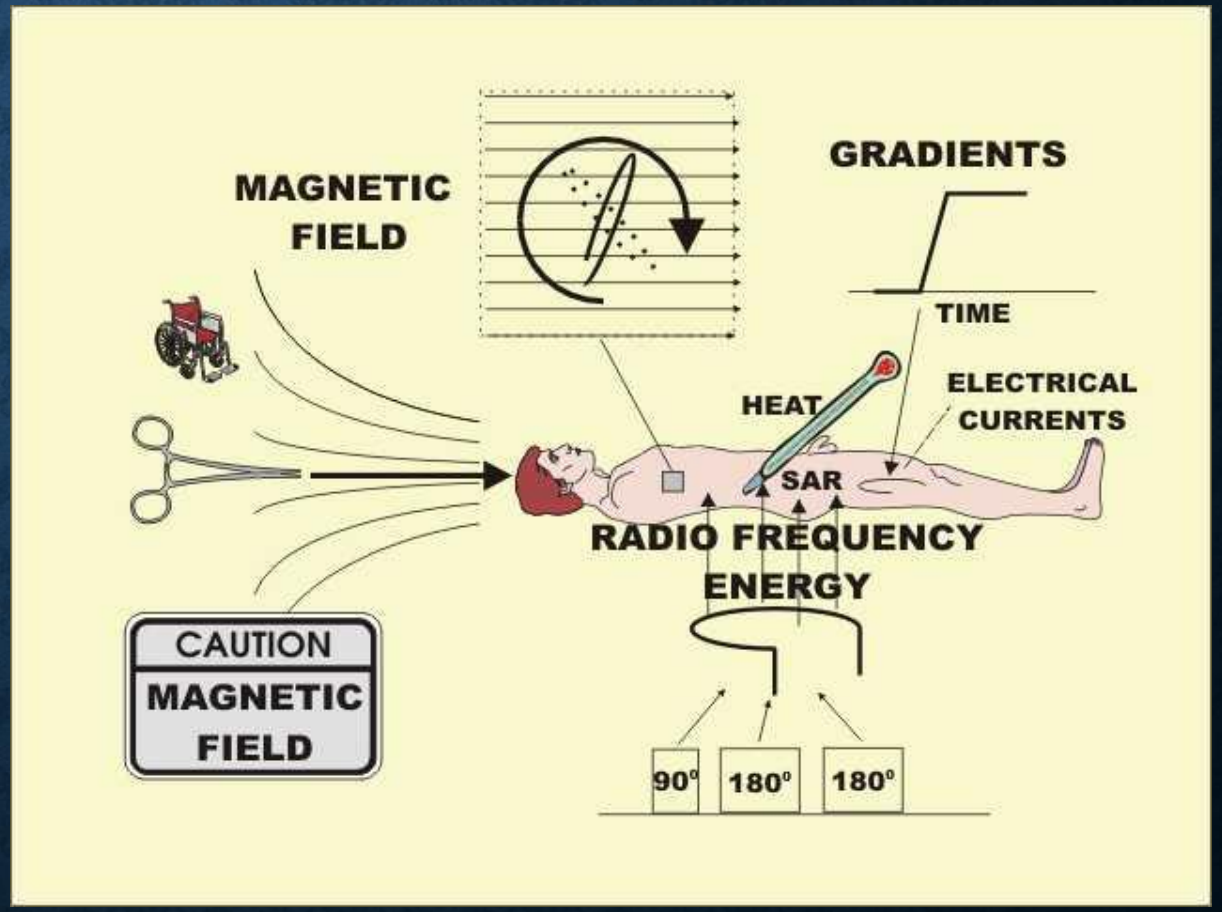
November 16, 2016

MR SAFETY

- Uses no ionizing radiation
- STRICT SCREENING FOR METAL IN THE BODY FOR ALL PEOPLE WHO ENTER THE MR ENVIRONMENT
- All equipment brought into the scanning environment must be MR safe
- No pregnant women
- The magnet will erase the magnetic strip on credit cards and will stop the battery in your watch.

BIGGEST HAZARDS IN MRI

- Effects of the Magnetic & RF Field
  - Strong static magnetic field
  - Pulsed gradient magnetic fields
  - Radio frequency fields
- Quenching of the magnet
- Contrast Agents
- Patient Discomfort



STRONG STATIC MAGNETIC FIELD (B_0)

- The magnet is capable of attracting a ferromagnetic object with considerable force, drawing it rapidly into the bore of the scanner
- No metal is to be brought into the MRI environment
- No jewelry, no metal in the pockets, no watches, hearing aids
- If subject has any potential of ferrous metal in their body, consider not scanning
  - Metal in the eye (even shavings) can be extremely dangerous
  - Metal lodged in bone is not as great of a risk as metal in soft tissue

MAIN MAGNETIC FIELD AND PROJECTILES

Missile Effect

MISSILE EFFECT

- https://www.youtube.com/watch?v=byRIwDk21sw
- https://www.youtube.com/watch?v=7g5UVrOt2CI

FERROUS DETECTION

- ❖Alarms ONLY for ferromagnetic objects
- ❖Can be used for superficial detection

Ferromagnetic detection is intended to supplement - but NOT replace screening procedures.

RADIOFREQUENCY FIELDS

- RF power transmitted is transformed into heat in the patient's tissue
  - Risk of patient heating/ thermal problems
  - Specific absorption rate (SAR) is the term used to describe the absorption of RF radiation
  - U.S. Food and Drug Administration indicate that MR procedures that exceed certain SAR values may pose significant risks
  - Also have SAR regulations on mobile phones
- RF fields can cause burns by producing electrical currents in conductive loops
  - If using equipment such as EEG leads, must not allow the wire to for a conductive loop with itself of the subject
  - No crossing legs or arms in the scanner

GRADIENT MAGNETIC FIELDS

- Changing magnetic fields induce electrical currents in conductive devices
- Rapidly changing magnetic fields excite peripheral nerves or muscle by inducing electrical fields
- At high levels, cardiac stimulation is a concern (much higher than typical MRI)
- Acoustic noise is produced as current is passed through the gradient coils during image acquisition (need ear plugs)

QUENCHING THE MAGNET

- What -
  - A quench is the sudden loss of superconductivity when the temperature is raised
  - Coil temperature rises above the superconductivity threshold, the windings suddenly develop a finite resistance
  - This creates heat causing a sudden, explosive boil-off of liquid helium
  - Creates a loss of the static magnetic field of the scanner
- Why -
  - Quenching can be done in emergency situations
  - Magnets can spontaneously quench

ALL MRI SCANNERS HAVE A QUENCH BUTTON

QUENCH

https://www.youtube.com/watch?v=RxJ2VyfFuW4

SAFETY ZONES FOR AREAS WITH MRI MACHINES

Zone 1: All areas that are freely accessible to the general public. (reception area)

Zone 2: Interface between the publicly accessible, uncontrolled Zone I and the strictly controlled Zones 3 and 4

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Zone 3: Region in which free access by unscreened non-MR personnel or ferromagnetic objects or equipment can result in serious injury or death as a result of interactions between the individuals or equipment and the MR scanner's particular environment. (Control area, access restricted with key locks, passkey systems etc.)

Zone 4: Synonymous with the MR scanner magnet room itself, that is, the physical confines of the room within which the MR scanner is located.

MAGNET ROOM ACCEPTABILITY LABELS

MR SAFE
an item which poses no known hazards in all MR environments

MR UNSAFE
an item which is known to pose hazards in all MR environments.

MR CONDITIONAL
An item which has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use. Field conditions that define the specified MR environment include field strength, spatial gradient, dB/dt (time rate of change of the magnetic field), radio frequency (RF) fields, and specific absorption rate (SAR). Additional conditions, including specific configurations of the item, may be required.

MRI SAFETY TRAINING VIDEO

- https://www.appliedradiology.org/coursereview.aspx?url=2794%2FInteractive%2FShellock_Intro_MRI_Sfty.html&scid=15694

- **Frank G. Shellock, PhD, FACR, FACC, FISMRM** *Adjunct Clinical Professor of Radiology and Medicine Keck School of Medicine, University of Southern California & Director for MRI Studies of Biomimetic MicroElectronic Systems, National Science Foundation, Engineering Research Center University of Southern California*..html&scid=15694

Boy, 6, Dies Of Skull Injury During M.R.I.

By DAVID W. CHEN

JULY 31, 2001

Outside of the X-ray, perhaps no other medical examination is as well known or as safe as the magnetic resonance imaging test, which is conducted eight million times a year in the United States on patients ranging from people with brain tumors to famous athletes with knee injuries.

But today, officials at the Westchester Medical Center announced that something went horribly wrong on Friday with an M.R.I. test on a boy, 6, who had just undergone surgery. Even though no metal objects are supposed to be in the testing area, because they will be pulled toward the 10-ton machine by its powerful electromagnet, a metal oxygen tank somehow made it into the examination room.
The tank, about the size of a fire extinguisher, became magnetized, then flew through the air at 20 to 30 feet per second and fractured the boy's skull.

The boy died on Sunday. And today, an autopsy conducted by the Westchester County Medical Examiner's office confirmed that he had died of blunt force trauma, severe hemorrhaging and a contusion to the brain. The hospital and the State Department of Health are investigating, and the Westchester District Attorney's office is also reviewing the case.

Model Number 07391167
Event Date 11/24/2013
Event Type Injury Patient Outcome Other
Event Description
It was reported that during a patient exam, an oxygen bottle was brought into the mr suite. The bottle was attracted to the magnet immediately resulting in injury to the physician in the room. The physician suffered a contusion and partial upper acl tear of the right knee. The patient was not injured and was removed from the exam room safely.
Manufacturer Narrative
The physician injured during the incident did not require hospitalization or further medical treatment. The mr system and exam suite have clearly visible signs regarding introducing ferrous metals to the exam room. Additionally, it is the hospital/ operator's responsibility to ensure that ferrous metals are not taken into the exam room. (b)(6).

Model Number 10432914
Event Date 11/24/2013
Event Type Injury Patient Outcome Other
Event Description
It was reported that a member of the cleaning staff brought a floor polisher into the mr suite resulting in the polisher being attracted to the magnet. The staff member received a cut to the right hand requiring 2 stitches.

Manufacturer Narrative
The injured person received 2 stitches to the right hand and did not require hospitalization or further medical treatment. We have not received any further reports regarding the condition of the injured personnel. The mr system and exam suite have clearly visible signs regarding introducing ferrous metals to the exam room. Additionally, it is the hospital/operators responsibility to ensure that ferrous metals are not taken into the exam room.

Model Number 781396
Event Date 11/20/2013
Event Type Injury Patient Outcome Other
Manufacturer Narrative
(b)(4). When the investigation is complete a follow up report will be sent to the fda.

Event Description
Phillips received a report from a customer that a patient was positioned head first supine and scanned with the small extremities coil in an ingenia 1. 5t mr system for a right wrist examination. The patient was positioned off center and touching the magnet bore cover with the left shoulder / upper arm. After the examination reddening of the skin and a blister of approximately 4cm was observed on the upper left arm.

Family: 79-year-old Dan Mahony died after accident involving metal walker at Zwanger-Pesiri Radiology in Medford

Originally published: January 20, 2014 1:47 PM Updated: January 20, 2014 7:53 PM

A family of an elderly war veteran is suing a Suffolk County radiology center after they say an accident there led to a stroke that killed him.

Dan Mahony, 79, was at Zwanger-Pesiri Radiology in Medford in 2009 to get an MRI. His son says his father was told to remove all metal from his body before the MRI, but he was never told anything about leaving behind the metal walker he used. Upon entering the room, the magnetic field was so strong his son says the walker was yanked out from under Mahony and he fell and hit his head on the floor.

Mahony suffered a stroke two days after the accident and died two months after that.

PORTLAND, Ore. — A teenage boy and his mother have sued a Portland hospital, alleging the boy was burned after a technician left metal discs on his body during a magnetic resonance imaging exam.

The Oregonian reports (http://is.gd/hMHZ4L) that Aaron Lee and his mother, Sharon, seek $2 million for pain and suffering and $30,000 in economic damages. The lawsuit was filed Wednesday against Oregon Health & Science University. Lee's lawyer Jane Clark says the boy was 16 and living in Vancouver, Wash., when he got the MRI in September 2011. He first received an electrocardiogram.

The lawsuit says patches containing metal discs were attached to his chest for the ECG and were not removed for the MRI, resulting in dime-sized burns when the metal heated up.

In a statement, the university said it couldn't comment specifically due to privacy laws but added that "patient safety is our top priority."

Clark says the boy now lives in New York

11/16/2016

Information from: The Oregonian, http://www.oregonlive.com

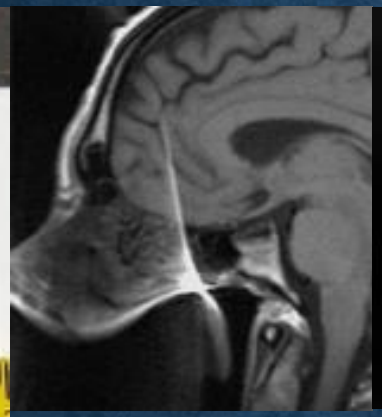
My claimant had an accepted back injury. She was referred to a facility for a MRI of her low back. Upon arriving at the facility she was given a nine page questionnaire that asked pages of questions on whether she had any metal or foreign object in or on her body. She said no to all of the questions. Then when she met with the technician she was again verbally asked all of the questions about any metal or foreign objects in or on her body and she again said no and re-signed the paperwork. She was too vain to tell the technician she had hair extensions that were in place with metal clips. When the MRI began her head and hair was pulled into all sides of the machine and her hair began to BURN and fried. She started screaming but the technician could not hear her and she was not quick to push the panic button. Once she pushed the panic button the technician stopped the machine. A massive amount of her hair along with her hair extensions was pulled out of her head and burned. She ammended her workers' compensation claim to include a psyche injury which we quickly denied. She is now trying to pursue a liability claim against the MRI facility. What women will do in vain for Beauty!

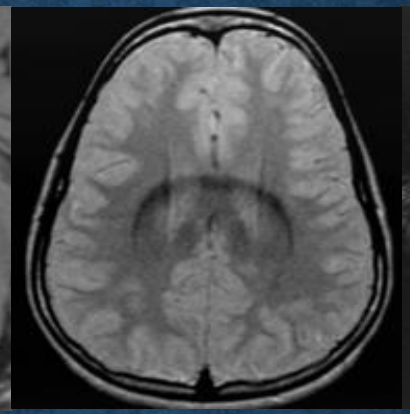
Submitted By: betty on January 28, 2011 to claimcrazy.com

METAL IN THE MRI MACHINE

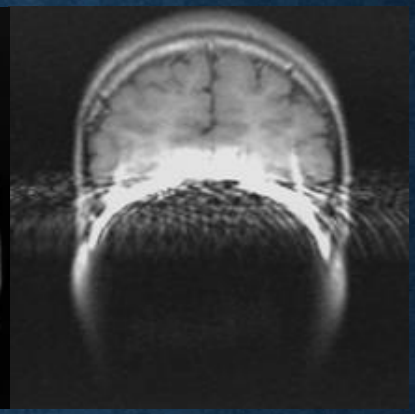
- Non-ferrous metal can be brought into the MRI environment
- These are not attracted to the magent but still interact with the magnetic field
- Interactions can lead to local distortions that cause artifacts in the MRI scan

ARTIFACTS FROM METAL



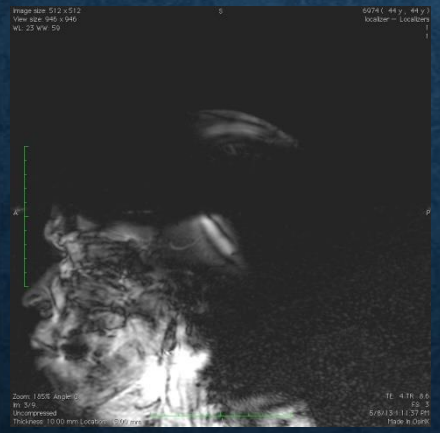


Dental Work

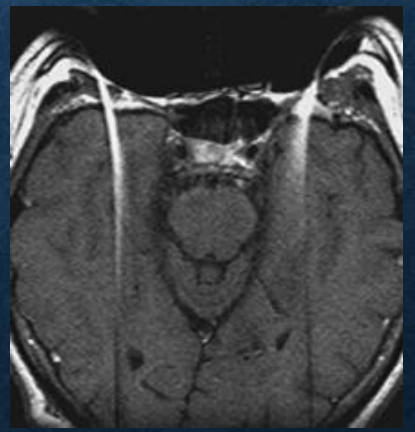


Braces

Nail Polish



Wig



Facial Repair

Images courtesy of Frank Shellock

MR INDUCED BURNS

https://www.google.com/search?q=pictures+of+mr