



Radiology Rounds

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MRI Safety

- MRI is generally very safe and adverse reactions to contrast agents are extremely rare
- Recent reports suggest an association between gadolinium contrast administration and nephrogenic systemic fibrosis in patient with moderate to severe renal insufficiency
- Cardiac pacemakers, implanted cardiac defibrillators, otic/inner ear/cochlear implants, and metal fragments in the eye contraindicate MRI
- Loose ferromagnetic objects can become dangerous missiles in an MRI room
- In order to ensure patient safety, all implants that contain metal must be verified as safe before an MRI procedure can be performed

MRI is generally regarded as a very safe imaging modality since it does not use ionizing radiation and because toxic reactions to MRI contrast agents are very rare. However, there are recent reports of an association between the use of gadolinium contrast agents in patients with moderate to severe renal insufficiency and the development of a newly discovered disease, nephrogenic systemic fibrosis, a debilitating or even fatal disease that affects the skin and other organs. Further details on this condition may be found on the PCOI Website, http://oi/pcoi/frontpage_frames.asp.

There are no data that shows that the high magnetic fields or the radiofrequency pulses used cause any adverse effects to the human body. However, the powerful magnets (10,000 – 30,000 times that of the earth's magnetic field) used in clinical MRI scanners can be hazardous because of the behavior of metals in a magnetic field. Ferromagnetic metals can become missiles that fly towards the magnet with high speed, which can cause serious injury or even death. Other metals develop an electrical charge or current when moved in a magnetic field with accompanying heat that can burn.

No loose metallic objects of any kind are allowed in the MRI room at any time because the MRI magnet is always left on to maintain the stability required for high quality images. Furthermore, the magnetic field is not confined within the bore of the magnet, but surrounds the magnet as well. The magnetic field is, however, confined within the MRI room by specially constructed shielding walls.



Access to the MRI environment is strictly controlled. In the Emergency Department, a red light comes on whenever someone enters the area.

For safety, no one entering the MRI room may carry anything metallic, including beeper, cell phone, and credit cards etc. (which have a magnetic strip that will be erased). In addition, everyone must also remove hearing aids, eyeglasses, dentures, hairpins, barrettes, jewelry, watch, and steel-toed boots/shoes. Note that these rules apply to a parent or family member who wishes to accompany a patient into the MRI room. Patients with any type of body piercing, regardless of specific location, must remove the jewelry in order to avoid skin burns. At this time, the only permitted metallic object allowed in the MRI room is a wedding band although this rule may change for patients who have an MRI in the new 3 Tesla scanner.

Surgical Implants and Prostheses

Many patients have metal-containing implants, some of which are safe in the MRI environment while others are not. Therefore, any metal-containing foreign body is a concern. In order to avoid accidental injury to patients, MGH has three-step safety check system that is designed to identify the individuals who have metallic implants or foreign bodies and prevent them from entering the MRI room until it has been established that it is safe to do so. The MRI requisition form has check boxes for special considerations that may contraindicate MRI, the patient will be asked to complete an extensive questionnaire before entering the MRI room, and the technologists will also verify that there are no contraindications.

Common "MRI Alert" Items Found via Patient Questionnaire

Intravascular stent
Wire sutures or surgical staples
Artificial joint replacements
Body piercing jewelry

MRI is strictly contraindicated for patients with pacemakers or otic (inner ear or cochlear) implants because these devices contain permanent magnets that can malfunction or cause injury when exposed to the high magnetic fields in an MRI room. Permanent magnets are also used to hold some prostheses, such as some orbital prostheses and dental implants, in place. These externally applied prostheses must be removed prior to the MRI procedure in order to prevent injury to the patient.

Another absolute contraindication for MRI is metal that has lodged in the eye or orbit. Therefore, patients are asked if they have worked in a machine shop or have had metal removed from an eye. If medical attention was needed to remove the metal fragment an x-ray examination of the orbits/eyes will be obtained to determine if there is still any residual metal fragments.

The risk of injury from other medical implants depends on the tissue into which it is implanted, the type of metal, and the time since it was placed. For example, aneurysm clips or heart valves can cause injury if they are ferromagnetic. However, most devices of this type implanted after 1996 are made of MRI compatible material. Nevertheless, to ensure safety, a radiologist or radiology technologist must know the make, model, and serial number of the implant, which is normally given to the patient at the time of implantation. This information is essential in order to verify the safety of every single implant before a patient, visitor, or employee enters the MRI room. In some cases, implants have been verified as safe for a 1.5T but not for a 3T MRI scanner.

Other kinds of implants such as joint replacements or sternotomy wires do not pose any danger once granulation tissue has developed around them although they will cause localized distortion of MR images. In addition to implants, extensive tattoos and some kinds of make-up contain enough metal particles to have the potential to cause heat injury although this is rarely a problem.

Relative Contraindications for MRI	
Absolute Contraindication	Pacemaker Otic implant Metal in eye or orbit Implanted cardiac defibrillator
Likely Contraindication	Heart valve or aneurysm clip installed before 1996
Possible Contraindication	Heart valve or aneurysm clip installed after 1996 Any type of prosthesis
Usually Allowable 6-8 weeks after implantation	Passive implants, weakly ferromagnetic (e.g. coils, filters, and stents; metal sutures or staples)
Usually Allowable immediately after implantation	Passive implants, non ferromagnetic (e.g. bone/joint pins, screws, or rods; coils, filters, and stents; metal sutures or staples) Rigidly fixed passive implants, weakly ferromagnetic (e.g. bone/joint pins, screws, or rods)
Caution	Tattoos

Pregnancy and Breast Feeding

There are no known risks for undergoing MRI scanning during pregnancy. However, late effects on the fetus may be unrealized since MR scanning has been widely available for only approximately 15 years. All pregnant patients will be asked to sign a consent form. Although gadolinium based contrast agents have not been found to cause any harm to the fetus, these have not been FDA approved for use in pregnancy and are not used as a general precaution. All pregnant patients should consult with an obstetrician prior to undergoing an MRI examination. If gadolinium contrast agent is used in a mother who is breast feeding her baby, she will be advised to abstain from breast-feeding for 24 hours because gadolinium passes into the milk and to express milk and discard it. In anticipation of the study, the mother may wish to obtain enough milk to feed the infant during the 24-hour period following the exam.

Sedation and Anesthesia

Some patients, such as pediatric patients or those with dementia or extreme claustrophobia, may be unable to remain still for an MRI examination. In these cases, sedation may be required and, with prior arrangements, can be administered. For conscious sedation, a specialized nurse will be present to monitor the patient. If general anesthesia is necessary, an anesthesiologist will be present throughout the procedure to monitor the patient. In both instances, the patients will go to a recovery room after the MRI procedure.

Scheduling

MRI is performed at Mass General West Imaging in Waltham, Mass General Imaging in Chelsea, and the Charlestown Navy Yard, as well as in the Yawkey Center and the Ellison building on the main MGH campus. If conscious sedation or anesthesia is required, the MRI must be performed on the main campus. Appointments at all locations can be scheduled by calling 4-XRAY (617-724-9729) or through the web-based Radiology Order Entry system, <http://mghroe/>.

The Patient Experience

Before an MRI, patients may continue to take medications as normal. Usually there are no any restrictions on food and drink. Before entering the MRI room, all patients must be wearing a hospital gown that has ties, not snaps, and remove anything metallic, including jewelry, dentures, hearing aids, and glasses. Once in the MRI room, the patient will be asked to lie down on the patient table and, if a contrast agent is to be used, a technologist will insert an IV line in the patient's arm. All patients are given earplugs or head phones to muffle the loud knocking noises made by the MR scanner during an examination. Immediately before the scan, patients are slid into position into the MRI tube. Although the tube is narrow, patients are able to see out by looking in a mirror, which reduces claustrophobic feelings. The technologist can observe the patient at all times during the procedure and will talk to the patient after each set of MR images.

The total scanning time is usually about 45 minutes, broken into several short segments. During this time, the patient must lie still. The technologist will let the patient know how long each segment will last and, if necessary, ask the patient to hold her breath for up to 30 seconds. During the scan, the patient should not experience any sensation except for the sound of the scanner and the motion of the bed. As a precaution, all patients are given a squeeze ball alarm and instructed to alert the technologist if they experience any abnormal sensations.

Further Information

For further questions, please call [Sherry Piskadlo](#), MRI Operations Manager, at 617-724-4220 and from the web at <http://www.mrisafety.com>

A brochure, entitled *A Patient Guide to an MRI scan*, is available at <http://www.massgeneralimaging.org> and copies of the printed version may be obtained by contacting [Kristen Dean](#) at 617-724-4902. In addition, information on preparing your child for MRI, including a recording of the [sound of an MRI scanner](#), is available online at <http://www.mghpedirad.org> and a booklet *My MRI*, written by Emily Sumner when she was 7 years old, can be found online at <http://www.massgeneral.org>.

References

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