MRI Safety of Some Commonly Encountered Devices: A Quick Guide for Radiology Residents

U.S. Food and Drug Administration labeling criteria for portable objects (developed by American Society for Testing and Materials International): New terminology



MR Safe: An item that poses no known hazards in any MR environment. Using the new terminology, MR safe items include nonconducting, nonmetallic, nonmagnetic items, such as a plastic Petri dish.



MR Conditional: An item that has been demonstrated to pose no known hazards in a specified MR imaging environment with specified conditions of use. Conditions that define the MR environment include static magnetic field strength, spatial magnetic gradient, dB/dt (time-varying magnetic fields), RF fields, and SAR. Additional conditions, including specific configurations of the item (eg, the routing of leads used for a neurostimulation system), may be required.



MR Unsafe: An item that is known to pose hazards in all MR environments. MR unsafe items include magnetic items such as a pair of ferromagnetic scissors.

*"MR compatible" in the old terminology has often been misused and is excluded from the new terminology to avoid confusion.

Coronary artery stents (bare metal and drug-eluting), peripheral vascular stents (including carotid artery stents), and aortic graft stents

- Most are MR safe or MR conditional (non-ferromagnetic or weakly ferromagnetic).
- Non-ferromagnetic stents: May be scanned at 3T or less immediately after implantation.
- Weakly ferromagnetic stents: Advised to defer MRI for about 6 weeks after implantation unless benefits of the MR exam outweigh risks.
- Zenith AAA endovascular graft stent [Cook] is **MR unsafe**.
- Potential risks of untested or ferromagnetic stents include stent migration and minimal-to-

moderate heating (<1 °C for a single stent and <2 °C for 2 long, overlapping stents in a coronary artery stent study), which may result in vessel damage.

• Endologix and Lifepath AAA stent grafts are MR safe, but MRI is not recommended as the modality of choice for targeted evaluation of these stent grafts due to significant artifacts.

Prosthetic heart valves, annuloplasty rings, cardiac closure and occluder devices

- Most are MR safe (non-ferromagnetic or weakly ferromagnetic).
- May be scanned at 3T or less immediately after implantation if non-ferromagnetic.
- Advised to defer MRI for about 6 weeks after implantation if weakly ferromagnetic unless benefits of the MR exam outweigh risks.
- Sternal wires are generally considered MR safe.

IVC filters

- Most are MR safe (non-ferromagnetic or weakly ferromagnetic).
- Non-ferromagnetic IVC filters: May be scanned at 3T or less immediately after implantation.
- Weakly ferromagnetic IVC filters (Gianturco bird nest [Cook] and stainless steel Greenfield [Boston Scientific]): Advised to defer MRI for about 6 weeks after implantation unless benefits of the MR exam outweigh risks.
- Potential risks of untested or ferromagnetic IVC filters include filter dislodgement and heating, which may result in vessel damage.

Intracranial aneurysm clips and embolization coils

- Most are MR safe or MR conditional (non-ferromagnetic or weakly ferromagnetic).
- May be scanned at 3T or less immediately after implantation if non-ferromagnetic.
- Advised to defer MRI for about 6 weeks after implantation if weakly ferromagnetic unless benefits of the MR exam outweigh risks.
- Potential risks of untested or ferromagnetic clips/coils include clip/coil migration and heating, which may result in vessel damage and possibly death.

Cardiac implantable electronic devices (CIEDs): cardiac pacemakers, implantable cardioverter-defibrillators (ICDs), implantable cardiovascular monitors (ICMs), and implantable loop recorders (ILRs)

- Vast majority are **MR unsafe**.
- Some MR conditional pacemakers and ILRs became available in 2011.
- No ICDs are currently labeled MR conditional as of 2013 and none are expected to be clinically available for several years.
- Potential risks include unexpected programming changes, device dysfunction or damage (replacement may be required), early battery depletion, failure to pace, asynchronous or rapid

pacing, and heating of tissue adjacent to the leads, all of which may result in arrhythmia (ranging from asystole to ventricular fibrillation) and death.

- Should any MR exam be contemplated for a patient with a CIED, it is recommended that radiology and cardiology personnel with a fully stocked crash cart be readily available throughout the MR exam.
- Retained or fractured pacer/ICD leads after pacemaker or ICD generator explantation should be approached in the same manner as intact pacemakers/ICDs.
- Some pulmonary artery hemodynamic monitoring/thermodilution catheters (e.g. Swan-Ganz catheter) and temporary transvenous pacing leads contain electrically conductive wires and are **MR unsafe**. Others that contain no electrically conductive materials are MR conditional.
- Retained temporary epicardial pacing wires are believed to be MR safe (no report of related complications to date), and patients do not need to be routinely screened for the presence of such wires before MRI.

Miscellaneous

- Neurostimulation systems (e.g. deep brain, spinal cord, and vagal nerve stimulation devices): MR conditional or MR unsafe depending on types, models, and manufacturers. Potential complications may occur with the device turned on or off and include device dysfunction/damage, pain, thermal injury, and death. More detail available on www.mrisafety.com.
- **Cochlear implants:** MR conditional or **MR unsafe** depending on types, models, and manufacturers. Potential risks include device dysfunction/damage and tissue injury. More detail available on <u>www.mrisafety.com</u>.
- Skin staples and superficial metallic sutures: Permitted for MRI if not ferromagnetic. If within the volume of RF coil transmission, warmth or burning sensation may occur; a cold compress or ice pack placed over the staples or sutures is recommended for the duration of the MR exam to prevent thermal injury.
- **Tattoos:** Warmth or burning sensation may occur with extensive or dark tattoos. A cold compress or ice pack placed over the tattoos is recommended for the duration of the MR exam to prevent thermal injury. Potential smearing may occur in tattoos freshly placed within 48 hr before MRI.
- **Drug delivery patches and pads:** Metallic foil contained in some may result in thermal injury. If within the volume of RF coil transmission, removal of the patches/pads prior to MRI (if possible) or placement of a cold compress or ice pack over the patches/pads for the duration of the MR exam is recommended.

Important note: Having undergone prior MRI in presence of an unspecified or untested device

without complications does not guarantee safety of future MR exams as MRI conditions may vary from one exam to another.

References

- Kanal et al. ACR Guidance Document on MR Safe Practices: 2013. *Journal of Magnetic Resonance Imaging*. 2013;37:501-530.
- Levine et al. Safety of Magnetic Resonance Imaging in Patients with Cardiovascular Devices. *Circulation*. 2007;116:2878-2891.
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