Shielding from Harm: The MRI Screening Tool—The First Line of Defense in MRI Safety

■ Lora K. Ott, PhD, RN

Magnetic resonance imaging (MRI) poses multiple levels of risk to patients and providers. Those working with MRI need to be continually conscious of the associated risks to prevent adverse events. The MRI screening tool, used to initially screen patients for safety risks in the MRI environment, is the first line of defense to protect patients from harm. The screening tool is often initiated by nursing, either nurses working in the radiology department or the bedside nurses caring for patients in the hospital. A better understanding of the risks inherent to the MRI environment and the importance of the MRI screening questions by nursing may result in improved patient screening, thus better care of patients in MRI. I recently had the privilege to sit down with Dr. Emanuel Kanal, a passionate advocate of MRI safety, to talk about the MRI screening tool and why we ask the questions we ask. Presented here is a summary of that conversation.

THE INHERENT RISKS OF THE MRI ENVIRONMENT

There are several things in MRI that we need to always remember. First and foremost, there is a powerful magnetic field. Whatever you are thinking about how powerful that magnet is, it is actually much stronger than that. We are used to magnets like the ones on our fridge or the ones we play with, even strong magnets that may be hard to pull apart. We may understand magnetism, but it is the level of the magnetic field that sets MRI apart. In our daily lives, we are not familiar with magnets so powerful that they can pull a car. With such powerful magnetic fields, it is relatively easy to be caught off guard.

The second aspect of the MRI environment to remember is that the magnetic field is always on for 24 hours a day. The magnetic field is generated by electrical flow but because of a phenomenon of physics called superconductivity, as long as the magnet is maintained at a cold temperature, once that magnetic field is generated it will last essentially forever. So even when the MRI environment looks like it is shut down—there is no noise, no lights, no humming—even if power to the building has been shut off. It is still exactly as powerful as it was during the daytime when patients were being scanned. The fact that the field is constantly present has been known to cause maintenance, security, and housekeeping workers to be caught off guard. There are many reports of tools, housekeeping machines, and even fireman's axes being pulled into the magnet from unsuspecting workers.

Besides that ever present static magnetic field, the third thing to remember is the additional magnetic fields that are present only when a person is being scanned. These are also magnetic fields, loosely referred to as radio waves, but which are actually radio frequency (RF) oscillating magnetic fields. We bombard the patient with these so-called radio waves and, then we listen to the body's response. We transmit RF pulses into the patient hundreds of times per second, actively probing their body and listening to their body's response during MRI. These RF pulses have their own safety issues, the most common of which are burns or heat generation. Every one of those RF pulses deposits power or energy into the patient. If you transmit enough of them or have enough power behind them long enough, you will heat up the patient. There have been cases of patients developing burns, first-, second-, third-, and

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even fourth-degree burns. It is rare, but there have been amputations that have been required because of burns sustained in the MRI scanner (Haik, Daniel, Tessone, Orenstein, & Winkler, 2009).

THE ACCURACY OF THE PATIENT'S HISTORY IS CRUCIAL TO MRI SAFETY

It is important that nurses recognize that although we are expecting the screening from the nurse or the technologist, the ultimate legal responsibility as to what decisions are made regarding scanning that patient based on the screening information belongs to the physician. The nurse may find out that the patient has a device, an implant, or a retained wire embedded or implanted within them. That information may be critical as it can make a substantial difference as to whether that patient can be safely scanned. That information, therefore, has to reach the radiologist who will make a decision as to whether it is safe to proceed with the requested scan. Absolute contraindications to an MRI scan because of an implant or device are the exceptions, not the rule. Pacemakers are a good example of that. Although many believe that you cannot scan a patient with a pacemaker, there are some pacemakers that can safely undergo MRI under specific conditions and circumstances. Even if they do not have the Food and Drug Administration stamp of approved as MRI conditional, there are some pacemakers that under certain circumstances could still be scanned if they were monitored with an electrophysiologist, and the transmitted RF power can be decreased to acceptable levels.

Sometimes a patient may have had a pacemaker removed, but a lead did not come out easily, so it was left behind within the patient (known as a retained or abandoned lead). The presence of an abandoned lead may make a major difference as to whether the patient can safely undergo the requested MRI study. Furthermore, some MRI studies may be safely performed on patients with abandoned leads, whereas others might not.

We cannot decide whether an implant can or cannot be safely scanned without first knowing that there is an implant present in the first place. It does not have to be an implant in the sense of a medical implant. It could be foreign bodies in the body, such as shrapnel. Years ago, we had a young gentleman come into the Pittsburgh MRI Institute, we had screened him by phone the evening before, and he came the next morning for his examination. He arrived for his MRI study with a Band-Aid on his forehead. The nurse went through the screening process again immediately preceding the requested MRI study and then asked him "What is the Band-Aid for?" He said, "Last night my brother shot me with a BB gun." This is one of the reasons why there are always at least two levels of screening before a patient is cleared into an MR scanner. Anything that was inside that human that they were not born with the radiologist definitely wants to know about it.

COMMON CONCERNS OF PATIENTS BEFORE THEIR MRI SCAN

Orthopedic Hardware

The material that we use in orthopedic hardware is almost never a significant issue for MRI. To withstand the heavy loads required by orthopedic hardware, it is often made from nonferrous magnetic metals, meaning they are not attracted to magnetic fields. Orthopedic hardware often does not pose a threat for heating or motion. However, they can cause significant artifact interfering with the scan so we still need to know what and where the patient has hardware. Ironically, leads and wires are more concerning for heating in an MRI than are orthopedic hardware.

Dental Implants and Braces

There are all different types of braces. There are the wires and the brackets cemented to the tooth. The brackets can be ferromagnetic (attracted to the magnet). They could be ceramic or a metal that would not significantly interact with the magnetic field. One cannot therefore generalize as to what the dentist chose to use. If it is ferromagnetic, it will cause a much larger artifact on the images. Braces on the teeth can destroy the imaging of much of the brain. Dentures and retainers are taken out not so much for the safety of the patient but for the potential of generating artifact on the images, especially for brain images.

Tattoos and Body Piercing

Tattoos are only a problem if it is in the region to be examined. It is therefore important to know if the patient has tattoos and where they are located. A massive tattoo on the chest will not interfere with an MRI of the knee. However, if the tattoo is in the region directly being scanned, then we may have to place a cold compress on that area to prevent heating. The energy we are using to examine the neck, for example, is concentrated around the upper body, while a transmit-receive antenna is typically used for an MRI of the knee, which concentrates the transmitted energies over the legs.

Even things like makeup, which can be made from iron oxide, can cause artifact around the orbit of the eye. This is more of an artifact issue, but there have been women who have had inflammation of the eye