

The Pre-MRI Screening Questionnaire: Purpose and Rationale

Note: "MRI environment" refers to all space within the 5 gauss line of the MRI system, which is the field strength established by the FDA as a lowest field strength for which no precautions need be taken. The "MRI magnet room" refers to the room that houses that MRI magnet. Entry to this room is restricted by large doors. The room is large enough so that the missile effect (described below) does not occur outside of this room.

In 1994, the Safety Committee of the Society for Magnetic Resonance (previously designated at the Society for Magnetic Resonance Imaging and presently called the International Society for Magnetic Resonance in Medicine) published screening recommendations and a questionnaire that encompassed all known issues (3). These recommendations were developed as a consensus from an international panel of MR experts and were intended for use as a standard of care at all MR centers. Elster et al. (6) also published a screening recommendation in 1994. This information was similar to the content of the recommendations provided by the Safety Committee.

The initial screening process should involve completion of a pre-MRI questionnaire that is specifically designed to reveal reasons that the patient might have an adverse reaction to the MRI procedure (1-3, 6, 15). The questionnaire must include questions concerning previous surgery, prior exposure to metallic slivers or fragments that may have entered the eye, and pregnancy. The questionnaire should determine whether the patient has on or within their body any implant, material, device and or other items that are considered to be hazardous in the MRI environment, or present a difficulty in achieving high image quality. This includes any device that is electrically, magnetically, or mechanically activated. A diagram of the human body should be provided for the patient to indicate the position of any such object (1, 3, 6, 22, 23). The screening questionnaire should also be used to obtain additional information on a variety of different topics related to the safe performance of the MRI procedure.

Pre-MRI Screening and Metallic Objects

Numerous studies have assessed the relative safety of performing MR procedures in patients with biomedical implants, materials, or devices (1, 2, 7, 9-18). These studies establish what type of metallic objects a patient may have and yet be permitted into the MRI environment without undue risk.

Investigations have generally demonstrated that an MR procedure may be performed safely in a patient with a implanted metallic object if it is non-ferromagnetic or if it is only minimally attracted by the static magnetic field in relation to the in vivo application of the object (7-17).

Pre-MRI Screening for Metallic Foreign Bodies

The presence of an electrically, magnetically, or mechanically activated device is usually considered to be a contraindication for an MR procedure (1-21). Therefore, any patient with

this type of device typically must be excluded from the MR environment unless, of course, the particular device is documented as being unaffected by the MRI environment (1-3, 817).

All patients that have a history of being injured by a metallic foreign body such as a bullet, shrapnel, or other type of metallic fragment should be thoroughly evaluated prior to entering the MRI environment (1-3). This is particularly important with respect to the static magnetic field of the MRI system because the exposure may cause serious injury as a result of movement or dislodgment of the metallic foreign body. Basic precautions described below should be taken with any type of MR system, regardless of the field strength, magnet type, and the presence or absence of magnetic shielding (1, 2, 5).

The relative risk of injury is dependent upon the ferromagnetic properties of the foreign body, the geometry and dimensions of the object, and the strength of the static magnetic field of the MRI system. The potential for injury is inversely related to the amount of resistance to movement the tissue provides to the object, and whether or not the object is positioned in or adjacent to a particularly sensitive tissue site such as a vital neural, vascular, or soft tissue structure (1, 2, 9-17).

Any individual with an intraocular metallic foreign body has a particularly high risk for significant eye injury if exposed to the static magnetic field of an MRI system (1, 2, 28-32). The single reported case of a vitreous hemorrhage, resulting in blindness, occurred during an MRI procedure performed using a 0.35 Tesla MR system (28). The patient had an intraocular metal fragment, 2.0 X 3.5 mm that moved under the influence of the main magnetic field as the patient exited the MR system (28). This incident emphasizes the importance of screening patients and other individuals with suspected intraocular metallic foreign bodies.

In general, plain film radiography appears to be an acceptable technique for identifying or excluding an intraocular or periorbital metallic foreign body that may present a potential hazard to the patient entering the MRI environment (1, 5, 6, 15, 26, 30). Any patient with a history suggesting the possibility of an intraocular metallic foreign body (e.g., a metal worker exposed to metallic slivers with a history of an eye injury requiring medical attention, a patient with a history of being a metal worker or fabricator, etc.) should have plain film radiographs of the orbits. These radiographs rule-out the presence of a metallic fragment (1, 5, 6, 15, 26, 30). If this plain film radiological exam cannot be performed, the patient should not enter the MRI environment, and such not have the MRI procedure.

If by history a patient is suspected of having a ferromagnetic intraocular foreign body, but has no history of an explicit injury to the eye, has no previous or present symptoms, and has had a plain film radiograph of the orbits that does not demonstrate a radiopaque foreign body, the risk of injury associated with exposure to the MR system is considered to be minimal (1, 3, 5, 6, 26).

If by history a patient is suspected of having a ferromagnetic intraocular foreign body, but since the reported incident in the history has had an MRI exam of the head without difficulty, in an MRI system with the same field strength, the risk of injury associated with exposure to the MR system is considered to be minimal.

In addition to being used to detect metallic objects in the ocular region, plain film radiography should be used when screening a patient for the presence of a metallic object located in any potentially hazardous site of the body (1, 5, 6, 15).

Pre-MRI Screening and Protection From "Missile Effects"

The "missile effect" refers to the capability of the fringe field of the static main magnetic field to attract ferromagnetic objects (e.g., oxygen tanks, tools, etc.) into the MR system with a considerable force (1). These objects effectively become missiles that fly into the bore (center hole) of the MRI magnet. The missile effect can pose a significant risk to the patient in the bore of the MR system and anyone in the path of the ferromagnetic object being attracted.

To guard against the missile effect, the area around the MR system must be clearly demarcated and labeled with appropriate warning signs, and monitored by trained technical staff. Patients and other individuals that wish to enter the MRI magnet room are first screened by the MRI Technologist, to remove all objects that may become missiles. Patients and other individuals are educated about the hazards of the fringe field of the magnet, before entering the MR magnet room.

For patients preparing to undergo an MR procedure, all metallic personal belongings (i.e., analog watches, jewelry, etc.) and devices must be removed. If body imaging is being performed, clothing items that have metallic fasteners, loose metallic components, or metallic threads must be removed. These same precautions are necessary for other individuals that may enter the MRI magnet room. An effective means of preventing a ferromagnetic object from inadvertently becoming a missile is to require that patients and accompanying individuals remove all objects (e.g., pens, paperclips, pins) from their pockets and hair before entering the MRI environment.

Wheel chairs and gurneys brought to the MRI environment must be inspected for the presence of ferromagnetic components. Only non-ferromagnetic wheel chairs and gurneys are allowed in the MRI magnet room. There are several commercially-available, MRI safe wheelchairs and gurneys that may be used to transport and support non-ambulatory patients to and from the MRI environment.

Ferromagnetic oxygen tanks, that may accompany patients in wheelchairs and gurneys, pose a particularly severe hazard, and are strictly prohibited from entering the MRI magnet room. Non-ferromagnetic MRI-compatible oxygen delivery systems are commercially available.

Extraction of a ferromagnetic object from a superconductive MR magnet often requires that the main magnetic field be brought to zero field strength, in a "controlled run-down" of the main magnetic field. Due to service costs, loss of cryogenics and loss of clinical use, such extraction costs ten thousand dollars or more.

Pre-MRI Screening and Pregnant Patients

The guidelines issued by the United States Food and Drug Administration state that the safety of MR when used to image the fetus has not been established or proved. Patients should be provided this information, but should also be informed that there are presently no known deleterious effects related to the use of MR procedures during pregnancy (1, 2, 4, 15).

Pre-MRI Screening and Tattoos

In the questionnaire, the patient is asked if he or she has ever had any type of permanent coloring technique (i.e., tattooing) applied to any part of the body. Tattooing includes cosmetic appellations such as eyeliner, lip-liner, and decorative designs on the skin. Questions regarding tattoos are necessary because a small number of patients (fewer than 10) have experienced transient skin irritation and or cutaneous swelling at the tattoo site in association with MR procedures. Tattoos may also create image artifacts which compromise the usefulness of the images.

Tattoos with pigments containing iron oxide or other ferromagnetic substances are more likely to cause adverse effects (8, 29-30). Pigments that are black or blue in color are likely to be ferromagnetic. The pigments interact with the electromagnetic fields used in MRI procedures, producing localized heating (8, 28). One patient developed eye irritation from her makeup (which contained ferromagnetic particles) which was displaced from her eyelid onto her eye during the MR procedure (8).

Only a few patients with tattoos have had adverse effects directly related to their tattoos, and these have been mild and short term. The risk in performing an MR procedure in a patient that has a tattoo is unlikely to outweigh the benefit of the examination, in particular if the diagnostic information provided by MRI is critical to the care of the patient. Overall, the risk of tattoos is considered to be minor.

About the Pre-MRI Screening Form

The Pre-MRI Screening Form is a comprehensive survey designed to avoid adverse events, injuries, or problems associated with using an MRI system. The Pre-MRI Screening Form asks important questions about the patient's past history that might be relevant to the safety precautions of the MRI environment. For example, the patient is questioned as to whether he or she had a previous surgery. The answer to this question helps the MR Technologist determine whether an object may have been implanted in the patient's body that could be a risk to the patient in the MRI environment.

Additionally, the form asks for the dates and locations of previous diagnostic imaging procedures that may have relevance to assessing the safety of the current MRI examination.

The form also includes a question to determine if the patient had a prior injury to the eye by a metal object (e.g., metallic slivers or shavings). A "yes" response to this question alerts the MR Technologist to ask specific additional questions, and to obtain x-ray plain films if necessary.

Pregnancy must be identified prior to exposure to the MRI environment so that the risks and benefits of the MR procedure may be carefully considered by the referring physician, patient, and radiologist.

Questions about drug allergies are included so that the MR technologist is aware of the medical condition of the patient and is alerted to any possible drug interactions in the event that additional drugs must be administered in a life-threatening situation.

The second page of the Pre-MRI Screening Form includes a comprehensive checklist of objects arranged, in descending order, by their relative hazard to the patient. A list of items that may produce image artifacts which interfere with the interpretation of the MR images is also included. A diagram of the human body is provided for the patient to indicate the location of any object that would be potentially hazardous, or would cause an image artifact that could interfere with the interpretation of the MR images. A short list of common objects that may become projectiles or "missiles" is also included to insure that patients remove these metal objects prior to entering the MRI magnet room. Finally, a statement at the bottom of the checklist informs the patient completing the Pre-MRI Screening Form that hearing protection is required during the MR procedure.

The Pre-MRI Screening form must be completed for each patient, each and every scanning session. A previous MRI examination completed without incident does not guarantee future safe examinations. For example, the risk of injury from implanted shrapnel varies as a function of field strength. Risk of injury also varies with the orientation of the patient, anatomy being imaged, or ferromagnetic implanted object, in the magnetic field.

Pre-MRI Screening References

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