MRI Safety and Orthopedic Implants

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By Frank G. Shellock, PhD, FACC, FACSM [1]

Most orthopedic implants are made from nonferromagnetic materials and, therefore, tend to be acceptable for patients undergoing MRI examinations. In vitro testing conducted at 1.5T and 3T has verified the safe aspects of orthopedic devices with regard to magnetic field interactions (see www.MRIsafety.com [2] for a summary of this information).

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To date, only the Perfix interference screw used for reconstruction of the anterior cruciate ligament has been found to be highly ferromagnetic. Because this interference screw is firmly embedded in bone for its specific application, however, it is held in place with sufficient retentive force to prevent movement or dislodgment. Patients with Perfix interference screws have safely undergone MR procedures using systems operating at 1.5T. The presence of the Perfix interference screw causes extensive image distortion during MR imaging of the knee. Therefore, interference screws made from materials with low magnetic susceptibility should be used for reconstruction of the anterior cruciate ligament if MRI is to be used for subsequent evaluation of the knee. Since the metals used for orthopedic implants are good conductors, MRI-related heating is a concern. In some cases, due to the length or formation of a conductive loop, MRI-related heating may be substantial, posing a potential hazard for a patient undergoing an MRI procedure. This is especially problematic for external fixation systems.

EXTERNAL FIXATION SYSTEMS

External fixation systems comprise specially designed frames, clamps, rods, rod-to-rod couplings, pins, posts, fasteners, wire fixations, fixation bolts, washers, nuts, hinges, sockets, connecting bars, screws, and other components used in orthopedic and reconstructive surgery. Indications for external fixation systems are varied and include the following treatment applications:

- open and closed fracture fixation
- pseudoarthrodeses of long bones (both congenital and acquired)
- limb lengthening by metaphyseal or epiphyseal distraction
- correction of bony or soft-tissue defects
- correction of bony or soft-tissue deformities

The assessment of safety issues for external fixation systems is particularly challenging because of the myriad of possible components, many made from conductive materials, and various configurations used for these devices. The primary concern is MRI-related heating, which is dependent on particular aspects of the external fixation systems. The MRI conditions used (field strength, radiofrequency field, RF transmit coil, pulse sequence, body part imaged, and so on) greatly affect the safety aspects of scanning patients with external fixation systems. In order to ensure patient safety, guidelines must be implemented on a case-by-case basis. Therefore, MRI users are referred to product labeling approved by the FDA for a given external fixation system. Safe MRI conditions typically apply to the specific configuration(s) used in the evaluation of a given fixation device only. Other configurations may be unsafe.

VIBRATION OF ORTHOPEDIC IMPLANTS

Graf et al reported that torque acting on metallic implants or instruments due to eddy current induction associated with MRI can be considerable. Larger implants such as orthopedic fixation
devices made from well-conducting materials are especially affected. Gradient switching was shown to produce fast alternating torque. Significant vibrations at off-center positions of the metal parts may explain why some patients with metallic implants sometimes report feeling sensations of heating during MRI examinations.

Dr. Shellock is an adjunct clinical professor of radiology and medicine at the Keck School of Medicine and director of MRI studies of Biomimetic MicroElectronic Systems (BMES) Implants, National Science Foundation BMES Engineering Research Center, University of Southern California, and Institute for Magnetic Resonance Safety, Education, and Research.

www.MRIsafety.com
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