Magnetic resonance imaging (MRI, MR), Functional MRI (fMRI)

This diagnostic modality provides physiologic information and detailed anatomic views of tissues and uses a superconducting magnet and radiofrequency (RF) signals to cause hydrogen nuclei to emit their own signals. Computers use the signals to construct detailed sectional images of the body. Intravenous/MR contrast agents are commonly used to allow for basic contrast and tissue signals.

Indications
- to differentiate diseased tissue from healthy tissue and study blood flow
- to evaluate multiple sclerosis, Alzheimer's disease, spine and cord abnormalities, neoplasms throughout the body, joint pathologies, cardiac function, and vascular pathologies.

Reference values
Normal
- Tissue signals and relaxation times reveal normal soft tissue structures of the brain, spinal cord, subarachnoid spaces (limbs, joints, fat, muscles, tendons, ligaments, nerves, blood vessels, and marrow), heart, abdomen, and pelvis (particularly liver, pancreas, spleen, adrenals, kidneys, and reproductive organs)
- Blood vessels: Normal size, anatomy, and hemodynamics

Post-test
- Evaluate patient outcome, and counsel appropriately.
- Monitor for sensitivity reactions and adverse reactions of gadolinium 50-DTPA contrast.
- Assess contrast injection site for signs of inflammation, bruising, irritation, infection, or extravasations of contrast agent.


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Clinical implications
- **MRI of brain/skull** demonstrates white matter disease (multiple sclerosis, infections, AIDS), neoplasms, ischemia, cerebrovascular accident, aneurysms, hemorrhage; this is the test of choice to evaluate bone lesions and fractures.
- **MRI of spine** demonstrates disc herniation, degenerations, neoplasms (primary and metastatic), inflammatory disease, and congenital abnormalities. No spinal contrast is needed.
- **MRI of limbs and joints** demonstrates neoplasms, ligament or tendon damage, osteonecrosis, bone marrow disorders, changes in blood flow.
- **MRI of heart** (cardiac MRI) demonstrates abnormal chamber size and myocardial thickness, valves and coronary vessels, tumors, congenital heart disorders, pericarditis, graft patency (cardiac), thrombic disorders, aortic dissection, and cardiac ischemia.
- **MRI of abdomen and pelvis** demonstrates neoplasms; especially useful in staging tumors, and tumor stage of abdominal organs (liver, pancreas, adrenals, spleen, kidneys), blood vessels, and abnormalities of renal transplants.
- **MRI angiography** (reference to noninvasive angiography) demonstrates aneurysms, stenosis, occlusions, graft patency, and vascular malformations.
- **Functional MRI** evaluates brain function while the patient is engaged in a task (such as finger tapping) or experiencing an auditory stimulus (such as music) and may demonstrate abnormalities related to dementia, seizures, tumors, or strokes.

Procedure
- For closed-system imaging, the patient is positioned supine before the couch is moved into the tunnel-shaped gantry. Assure the patient that there’s sufficient air to breathe and that he’ll be monitored during the entire procedure.
- Open MRI systems may be used in some centers.
- In some instances, a noniodinated venous contrast is injected for better visualization of anatomy. The most commonly used contrast agents are gadolinium 50-DTPA, gadolinium manganese, or iron, which has very low toxicity and much fewer adverse effects than iodine contrast agents. Gadolinium is generally used in examinations of the central nervous system (brain, vascular imaging, and spine).
- For abdominal or pelvic scans, glucagon may be administered to reduce bowel peristalsis.
- Exam times vary between 60 and 90 minutes.

Nursing interventions
**Pretest**
- Explain that fasting or drinking only clear liquids may be necessary for some MRI scans; also, no alcohol, nicotine, caffeine, or iron supplements may be taken before testing.
- Make sure that the purpose, procedure, benefits, and risks of the MRI have been explained to the patient.
- Sedation may be required if patient is claustrophobic or otherwise unable to lie still during the procedure.
- Assure the patient that a two-way communication system between him and the operator will allow for continual monitoring and vocal feedback.

**Intratest**
- Reassure the patient during testing.

**CLINICAL ALERT**
Safety concerns for the patient and staff during MRI procedures are based on interaction of strong magnetic fields with body tissues and metallic objects. These potential hazards are mainly due to *projectiles* (metallic objects can be displaced, giving rise to potentially dangerous projectiles); *torquing of metallic objects* (implanted surgical clips and other metallic structures can be torqued or twisted within the body when exposed to strong magnetic fields); *local heating* (exposure to RF pulses can cause heating of tissues or metallic objects within the patient’s body; for this reason, pregnant women aren’t routinely scanned because an increase in amniotic fluid/fetal temperature may be harmful); and *interference with electromechanical implants* (electronic implants are at risk for damage from both magnetic fields and RF pulses; consequently, those with cardiac pacemakers, implanted drug infusion pumps, cochlear implants, and similar devices shouldn’t be exposed to MRI procedures).