NEURO-ANESTHESIA & MRI

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1.65 Y/M develops weakness and numbness of legs and incontinence. He needs an urgent MRI of the lumbar spine. He is claustrophobic and needs anesthesia for the procedure. All the following are concerns about doing anesthesia in an MRI suite except;

A. One should avoid ferromagnetic objects in the MRI suite because of the projectile effect
B. Special monitors should be available
C. High level of acoustic noise is present
D. High level of radiation is present
A. One should avoid ferromagnetic objects in the MRI suite because of the projectile effect

The source of the electromagnetic force attracts any ferromagnetic object or instrument, such as pens, stethoscopes, scissors, IV poles, gas cylinders, laryngoscopes, non-lithium batteries and anesthesia machines. This ferromagnetic attraction poses potential injury to patients or staff in the operating room. If there is any doubt about the content of an object, a strong handheld magnet should be readily available outside the MRI suite to detect if the object is safe.
Patients who require anesthesia in the MRI suite must be provided with the same level of safety and monitoring as in the operating room. Therefore, adherence to the American Society of Anesthesiologists guidelines for non-operating room anesthetizing locations is mandatory.

One of the largest challenges for the anesthesiologist is coping with the high-energy iMRI generated Electrical Noise (EN). An iMRI system, generates pulsating high-energy RF signals and pulsating magnetic field gradients to capture a useful anatomic image. The RF generator can emit EN in the form of electromagnetic energy that can interfere with the operation of electronic patient monitors.
C. High level of acoustic noise is present

This is True.
The noise emitted from the MRI may average 95 decibels in a 1.5 T scanner [ref]. Auditory protection, such as ear plugs, should be provided to all patients to prevent hearing damage.

D. High level of radiation is present

There is no radiation hazard associated with MRI scan
2. The absolute contraindication to MRI is the following:

A. Pacemakers and Defibrillator
B. Pregnancy
C. Patient with a Deep brain stimulator
D. Patient with a Vagal nerve stimulator
A. Pacemakers and Defibrillator

The electrical and magnetic fields of the MRI scanner can potentially affect the function and safety of a pacemaker. Torsion and attractive forces are exhibited by the pacemaker in the presence of these fields. A number of major problems may occur with pacemakers in the MRI environment (Table).

(1) Electromagnetic interference
(2) Pacemaker reprogramming
(3) Pacemaker inhibition
(4) Reversion to an asynchronous mode
(5) Reed switch closure
(6) Dislodged
(7) Direct heating

Anesthesia for magnetic resonance imaging
Cheryl K. Gooden; Current Opinion in Anaesthesiology 2004, 17:339–342
B. Pregnancy

Pregnancy has not been proven by studies to be a contraindication for MRI. If Ultrasound is not feasible or inadequate, then MRI imaging may be necessary in the pregnant individual. Since there are no X-rays, there is no radiation hazard. The noise produced by the MRI has also not been proven to cause any hearing problems in the fetus.
C. Patient with a Deep brain stimulator

In the United States, the Food and Drug Administration (FDA) has approved the use of deep brain stimulation (DBS) for the treatment of essential tremor and Parkinson’s disease tremor and has granted a humanitarian device exemption for DBS in the treatment of primary dystonia and obsessive-compulsive disorder.

Yes, MRI can be performed in patients with a Deep brain stimulator. However, it should be turned off for the procedure to prevent re-programming.
Vagal nerve stimulators are used for refractory epilepsy. MR conditional devices are available. Only FDA approved device is the cyberonics vagal nerve stimulator which should be used with only transmit-receive head or local extremity coils. To prevent undesired stimulation during the MR scan, the cyberonics vagal nerve stimulator must be programmed to magnet mode output of 0 mA.

Electrical stimulation and monitoring devices of the CNS:
An imaging review Sohil H. Patela, et al.
3. All the following are true regarding an MRI suite except;

A. Quenching indicates loss of superconductivity of the magnet
B. Patient with a spinal cord stimulator can undergo MRI scan
C. With MRI safe EKG electrodes, one can monitor for myocardial ischemia
D. Sevoflurane and Isoflurane vaporizers are safe to use in an MRI environment while Desflurane is not.
A. Quenching indicates loss of superconductivity of the magnet

This is True.
Quench is one of the emergencies in the MRI suite leading to loss of superconductivity of the magnet and escape of Helium gas. If the quench tube became blocked or disconnected, allowing lethal quantities of helium to escape into the scanner room this could lead to hypoxia.
B. Patient with a spinal cord stimulator can undergo MRI scan

Spinal stimulators manufactured by Medtronic and Boston Scientific are considered MRconditional at 1.5 T. The stimulator needs to be turned off prior to scanning. Any external devices (patient control device, recharger, external neurostimulator, clinical programmer) are MR unsafe and should not be brought into the scanner room.
C. With MRI safe EKG electrodes, one can monitor for myocardial ischemia

The EKG electrodes and cables should be MR safe and contain minimal metal components. While the scanner generates an image, the magnet produces EN (Electrical noise) that disables the ECG waveform monitor and hence quality readings for diagnosing cardiac arrhythmias or ischemia are not possible.
Isoflurane and Sevoflurane vaporizers are safe but not Desflurane. There is negligible ferromagnetic material in vaporizers and mechanical ventilators, and with the exception of desflurane, these devices behave properly when introduced into MR environments. Isoflurane, enflurane, halothane, and sevoflurane vaporizers are MR safe and cleared for use in the low- and high-field MR environments. The desflurane vaporizer is not MR safe, however, and has not been cleared for use in MR environments.
4. The following are significant safety concerns in the MRI suite except;

A. Malfunction of all types of infusion pumps
B. Burn wounds related to equipment cables
C. Anaphylaxis from the use of intravenous contrast agent Gadolinium
D. Hearing damage due to high noise levels

Explanation contributed by-
Dr. Sonal Patel
Neuroanesthesia Fellow, Cleveland Clinic
A. Malfunction of all types of infusion pumps

The source of the electromagnetic force which is the magnet attracts any ferromagnetic object, including the infusion pump. The accuracy of the infusion pump can also be questionable in the MRI setting. Hence it is important to use MRI compatible pumps.
B. Burn wounds related to equipment cables

The use of standard ECG electrodes, leads and cables may cause excessive heating that could cause burns in the patient during an MRI procedure. During the operation of MR systems, electrical currents may be generated in the conductive materials of monitoring equipment that are used as part of the interface to the patient causing excessive heating and thermal injury to the patient.

Incorrect

Practice advisory on anesthetic care for magnetic resonance imaging by the American Society of Anesthesiologists Task Force on Anesthetic Care for Magnetic Resonance Imaging. Anesthesiology 2015;122:495-520.
C. Anaphylaxis from the use of intravenous contrast agent Gadolinium

Gadopentetate dimeglumine (gadolinium) is a MRI contrast agent that is injected to enhance imaging. Gadolinium has an elimination half-life of between 1.3 and 1.6 h. The major route of excretion is renal. The incidence of a life threatening anaphylactic reaction to gadolinium is extremely low. It can however cause nephrogenic systemic fibrosis.
An MRI is noisy because its magnetic field is created by running electrical current through a coiled wire—an electromagnet. When the current is switched on, there is an outward force all along the coil. And because the magnetic field is so strong, the force on the coil is very large.

A study recently published in the journal of Radiology found measurable post-MRI ear damage, muffled hearing—even in people wearing earplugs.

MRI Noise and Hearing Loss; Sheppard, Adam, AuD; Chen, Yu-Chen, PhD; Salvi, Richard, PhD

T MRI can alter hearing ability for weeks after exam - February 28, 2018 | Anicka Slachta

Hearing loss – American society of neuroradiology
5. With regards to management of patients for MR imaging,

A. In the event of a cardiac arrest, the magnet should be switched off in order for safe resuscitation to take place.
B. Patients with intracranial aneurysm clips should not have MRI scans unless deemed MRI conditional.
C. Patients with angina should keep their GTN patches on.
D. Intensive care patients should not have MRI if their tracheal tube contains a metal spring in the pilot balloon.

Explanation contributed by-
Dr. Deepali Garg
Neuroanesthesia Fellow, Cleveland Clinic
A. In the event of a cardiac arrest, the magnet should be switched off in order for safe resuscitation to take place.

When a patient has a medical emergency (e.g., cardiopulmonary arrest) in the MRI scanner, the following should occur: (1) immediately remove the patient from zone IV while initiating CPR, if indicated, (2) call for help, and (3) transport the patient to a previously designated safe area for resuscitation that is not in zone IV. This location should be as close to zone IV as possible so as not to delay resuscitation efforts and should contain the following resuscitation equipment: a defibrillator, vital signs monitors, and a code cart that includes resuscitation drugs, airway equipment, oxygen, and suction.

B. Patients with intracranial aneurysm clips should never have MRI scans

In the event that a patient is identified to have an intracranial aneurysm clip in place, the MR examination should not be performed. However, if the benefit of an MRI exam outweighs the risk, it has to be documented that the specific manufacturer, model, and type of aneurysm clip within that patient is MR Safe or MR Conditional. All documentation of types of implanted clips, dates, etc. must be in writing and signed by a licensed physician. Phone or verbal histories and histories provided by a non physician are not acceptable.
C. Patients with angina should keep their GTN patches on

Some drug delivery patches contain metallic foil. Scanning the region of the metallic foil may result in thermal injury. Because removal or repositioning can result in altering of patient dose, consultation with the patient’s prescribing physician would be indicated in assessing how to best manage the patient. If the patch is removed, a specific staff member should be given responsibility for ensuring that it is replaced or repositioned at the conclusion of the MR examination.
D. Intensive care patients should not have MRI if their tracheal tube contains a metal spring in the pilot ballon.

The pilot balloon of regular endotracheal tube contains a metal spring.
If a patient from the ICU is transported intubated, the pilot balloon should be taped securely to the endotracheal tube.