Learning From Others:

A Case Report From the Anesthesia Incident Reporting System

Anesthesia Quality Institute
ANESTHESIA INCIDENT REPORTING SYSTEM (AIRS)

Review of unusual patient care experiences is a cornerstone of medical education. Each month, the AQI-AIRS Steering Committee abstracts a patient history submitted to the Anesthesia Incident Reporting System (AIRS) and authors a discussion of the safety and human factors challenges involved. Real-life case histories often include multiple clinical decisions, only some of which can be discussed in the space available. Absence of commentary should not be construed as agreement with the clinical decisions described. Feedback regarding this article can be sent by email to the AIRS Committee: **airs@asahq.org**. Report incidents or download the AIRS mobile app at **www.aqiairs.org**.

Case: A 'Magnetic' Personality

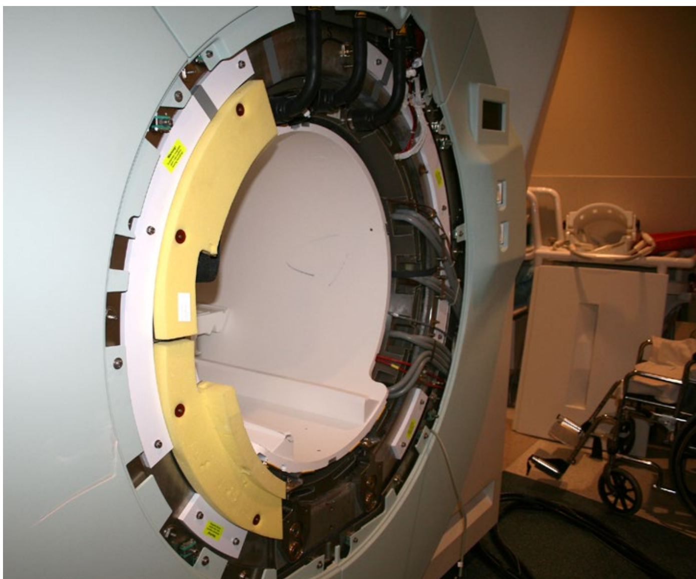
A healthy adult patient was scheduled for an MRI of his brain under general anesthesia in a 3 Tesla scanner. The resident was standing next to patient's head at the scanner's bore and was getting ready to extubate the patient. A metal pen suddenly flew out of her scrub pocket and into scanner. The pen was recovered and there was no injury to the patient. During the case, the resident and I had to enter and leave the scanner room (Zone 4) several times to adjust the monitors and I.V. tubing. The attending anesthesiologist also had a pen in his pocket, but it was plastic, which might have led the resident to think that all pens are O.K. We need to train our staff to always empty pockets whenever entering the scanner room.

Discussion:

More and more of our patients are undergoing procedures in remote locations, and physician anesthesiologists are learning to cope with the unique hazards that each new environment presents to the patient and to themselves. Management of patients undergoing imaging procedures poses unique challenges to any anesthesia professional, be it radiation from interventional procedures under fluoroscopy or the strong magnetic field of an MRI scanner. Although many clinicians would argue that MRI safety is "old news," this case proves that an occasional refresher might be good for everyone.

Magnetic resonance imaging (MRI) has been in clinical use for more than two decades, and until recently was used only as a diagnostic tool. Stronger magnetic fields and improved software are bringing advanced MR technology such as functional MRI, MR spectroscopy, diffusion tensor imaging and vascular imaging to the radiology suite and sometimes the O.R. The strength of a magnetic field is measured in either Gauss (G) or Tesla.[1] Tesla is equivalent to 10,000 Gauss. (For comparison, the strength of the earth's magnetic field is between 0.3 and 0.6 G, varying slightly with location.) MRI scanners in clinical use employ static fields that range between 1.5 and 3T. A second, time-varying magnetic field is applied across the static field at varying angles to excite protons, which in turn emit radiofrequency energy used to create the images.

The strong, static magnetic field is generated by a superconducting electromagnet that is energized when the scanner is installed, and it is always present, even when the scanner is powered down. Many imaging suites have 5 Gauss and 50 Gauss lines clearly painted on the floor. If a ferromagnetic item (e.g., a monitor, an oxygen tank or a pen) is brought closer than the 50 Gauss line, it may be pulled by the magnet. For this reason, equipment is classified as *MR safe* (nonmagnetic), *MR unsafe* (ferromagnetic and unsafe under any circumstances) or *MR conditional* (may be brought into the scanner room under a specified set of conditions).



A 3 Tesla MRI scanner shortly after a surgical light box was pulled into the bore.

It's very easy to forget about a pen in your pocket, or to bring an item such as a laryngoscope into the scanner room simply because you're holding it when you need to get to the patient. What's more, the patient isn't the only person at risk: A flying object can injure a colleague or cause severe damage to a very expensive piece of equipment. Simply telling everyone to be careful doesn't work. Any clinician who will be providing care in this environment should receive formal training on magnet safety. The best solution (one used by many MRI technologists) is to stop before entering the room and pat yourself down to make sure that nothing is in your pockets. Do this every time you enter the room. Anything that you find should be closely examined to make sure it's compatible with the MRI and won't cause injury. Anesthesia clinicians who will enter zone III or IV should themselves be screened for the presence of implanted devices, ferromagnetic materials or foreign bodies. When in doubt, always ask.

"The radiofrequency energy used to excite protons and produce the imaging data can cause tissue or device heating or burns, interfere with waveforms shown on the physiologic monitor (i.e., electrocardiogram), and it can induce current in conductors (e.g., cables or fluid-filled tubing), causing skin burns."

In addition to the obvious issue of magnet safety, the MRI can cause biologic effects in our patients and in us. Both the static and time-varying magnetic fields induce an electrical current in conductive tissues and medical devices in the patient's body. The interaction between the magnetic field and implanted devices can result in provider and/or patient harm, equipment failure, malfunction or movement. The biologic effects of the gradient magnetic field are believed to be limited only to peripheral nerve stimulation that is described as a tingling or tapping sensation or pain. The radiofrequency energy used to excite protons and produce the imaging data can cause tissue or device heating or burns, interfere with waveforms shown on the physiologic monitor (i.e., electrocardiogram), and it can induce current in conductors (e.g., cables or fluid-filled tubing), causing skin burns. Rapid motion in the static field near the scanner will produce an electrical current within the body of the patient or caregiver. Symptoms are most pronounced when the head is moved faster than 1 m/sec within or very close to the bore (where the magnetic field is strongest). The physiologic responses are varied and may include nausea, vertigo, headache, light flashes, loss of proprioception and metallic taste. In one study, instrumented phantom patients moving faster than 1 m/sec exceeded the recommended exposure limit of 40 mAm-2 in the head and trunk.

Finally, MRI-compatible equipment is generally very different from that used in the O.R. The anesthesia machine, patient monitors and even infusion pumps may be completely different from what the clinician is used to. The equipment may be placed outside the room, requiring long connections that create the risk of disconnection. At one of the author's institutions, the MRI-safe anesthesia machine lost power during a case because it had been running on battery without the team realizing it. No one knew how or where to plug in the machine. The patient had to be ventilated with a bag and mask, the anesthetic was switched to TIVA, and the anesthesia technicians were called "STAT."

Summary of safety tips for anesthesia in the MRI:

1. Ensure that neither you nor the patient has ferromagnetic materials. Perform a self "pat down" every time you enter the room.
2. Make sure that any implants in clinicians (even non-ferromagnetic, e.g., wire-enforced epidural catheters) are MRI safe because the magnetic field can create a current and heat in implanted wires.
3. Stay at least 0.5-1 meter from the MRI opening whenever possible.
4. Move slowly when near the bore (for example, to manage an airway) because rapid movement can cause current in the brain and nerves.
5. Familiarize yourself with the MRI equipment on a regular basis.

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