

Intraoperative Magnetic Resonance Imaging (iMRI) mishaps - Troubleshooting an unsafe object attached to the scanner

Sir,

The unfortunate incident of 2001, where an oxygen cylinder accidentally brought into the vicinity of a magnetic resonance (MR) scanner resulted in a fatal injury to a 6-year-old boy, has impressed upon the world the grave consequences of projectile injuries.^[1] Despite strict regulations and multiple guidelines near-misses continue to be reported. Incorporation of magnetic resonance imaging (MRI) into the intraoperative environment has added to neurosurgical armamentarium but has also potentially increased the scope for errors. We report an unsafe event in the intraoperative MRI (iMRI) operation room (OR). Our OR support worker was replacing fresh linen in the iMRI OR while preparing it for the second case. Due to the force of habit as in other ORs, on that fateful day, he entered the OR in a hurry with a monitor still in his hand. It led to the pulling of the transport monitor to the magnetic console [Figure 1]. This is how, despite many safety precautions and protocols in place, an MR unsafe transport monitor found its way into BrainSuite© iMRI. (Brainlab AG, Germany). BrainSuite iMRI holds both scanner and MR compatible table in the same room. Surgery is conducted outside the 5G line and the table is rotated 180 degrees to access gantry for a scan. Presence of theatre support workers doing duty in both iMRI as well as a normal OR resulted in an error of judgment.



Figure 1: MR unsafe monitor attached to the bore of MRI scanner

Fortunately, there were no physical injuries but the consequences of the event were, nevertheless, severe.

iMRI poses unique challenges which are unlike the diagnostic MRI suites. iMRI lasts for longer and complex therapeutic procedures, requiring more manpower and equipment (the navigation system, microscopes, endoscopes, drills, surgical instruments, neuromonitoring, and anaesthetic equipment) with limited options to handpick MR safe/conditional devices. These facilities are manned by a team of nurses, technologists, and cleaning staff who work in both iMRI ORs as well as normal ORs. iMRI setups are largely proclaimed safe. Tan *et al.*^[2] documented 43 MR undesirable incidents in 19 months of iMRI usage, none of which resulted in injury to the patient. However, 32.6% of these incidents were attributed to human errors and were preventable.

Troubleshooting of an undesired object attached to a magnetic bore is worth discussing [Figure 2]. Technical support is not readily available in iMRI, hence steps of troubleshooting, as well as contact details of engineers, should be well displayed. The pulling of objects stuck to the MRI is ill-advised. The magnetic force of a 3 Tesla magnet bore is 60000 times of the earth's gravitational field.^[3] Hence, it is near impossible to pull an object weighing a few kilograms (in our case, the monitor) against such force. Pulling might cause objects to fall back onto the scanner with force and result in damage both to the scanner and the attempting personnel (if trapped between the scanner and the object to be pulled). Objects may shatter during the pulling attempt; internal ferromagnetic components might disperse and result in flying objects causing injury. Pulling should only be reserved for very small objects. The Quench button should be used only in

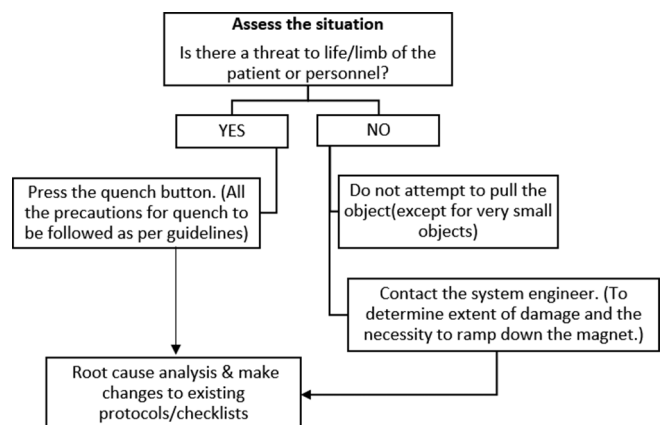


Figure 2: Steps of troubleshooting when object gets pulled into the scanner

an absolute (life/limb-threatening) emergency. Quench quickly shuts off the magnetic pull, but the economic burden of the process is huge due to the non-recovery of helium. The alternative is to slowly ramp down the magnetic field strength to the level sufficient to safely retrieve the object. Ramping down is associated with less helium loss and expenditure compared to a quench. However, it is a slow process (2-3 days), and ramping up takes time potentially rendering the MRI scanner unusable for a few days.

Strict enforcement of checklists and protocols is the key to avoid mishaps.^[4,5] A dedicated person with the sole responsibility to oversee screening and restrict entry, mandatory tutorials at regular intervals (to refresh knowledge and reiterate safe practices) and pocketless scrubs for personnel entering MR suite are some of the suggestions that could be implemented in the Indian scenario.^[6]

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