Letter to the Editor

MRI of Cervical Fixation Devices: Sensation of Heating Caused by Vibration of Metallic Components

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MRI is an essential technique used for evaluation of patients with cervical spine trauma who are treated by immobilization using cervical fixation devices that are specially-designed to be MR compatible (1–5). Recently, a few patients wearing cervical fixation devices have complained of heating or burning sensations localized to the positions of the front or back titanium skull pins while undergoing MRI procedures. In each case, there was no evidence of redness or swelling of the scalp surrounding the skull pins. (It should be noted that the actual number of patients undergoing MR procedures who have complained of heating and the specific details pertaining to these complaints are unknown because these are mainly anecdotal reports investigated retrospectively). These complaints were surprising because there has been no prior case of excessive heat developing in a metallic implant previously shown to be MR compatible based on acceptable peer-reviewed test methods (4–11).

To investigate this issue further, a halo ring and vest (removed from a patient who complained of severe "burning" in a front skull pin during MRI) was evaluated for heating or other potential problems associated with MRI. The halo ring and vest were connected and a fluid-filled Plexiglas phantom was placed within the vest. The device was then placed within a 1.5-T MR system and MRI was performed using the same parameters that were associated with the "burning" sensation, as follows:

T1-weighted spin echo, sagittal plane: TR = 434 msec, TE = 11 msec; field of view = 24 cm; matrix size = 256 × 256; 2 NEX; 4-mm slice thickness; 1-mm gap.

T2-weighted fast spin echo, sagittal plane: TR = 4,000 msec, effective TE = 102 msec; echo train length = 16; field of view = 24 cm; matrix size = 256 × 256; 2 NEX, 4-mm slice thickness; 1-mm gap.

One author (R.C.H.) remained within the MR system to visually observe and touch the cervical fixation device during the MR procedure. There was no perceivable temperature change noted for any of the metallic components during MRI. However, the metallic components of this device (eg, halo ring, vertical supports, vest bolts, etc.) vibrated substantially during MRI. Of additional note is that when the skull pins were held firmly during MRI, there was a "drilling" sensation that could be interpreted as a "searing" or "burning" effect. However, the skull pins remained cool to the touch throughout the MR procedure.

In a soon to be published article (11), the MR compatibility of various cervical fixation devices was studied for a variety of configurations (Mark IV vest and Trippi-Wells tongs; Mark IV vest and open-back halo; Mark IV vest and open-back halo with Delrin inserts; Mark IV vest and closed-back halo; Mark III vest and open back-halo; Ace Medical Co., El Segundo, CA). An eight-probe, Luxtron Model 3000 fluoroptic thermometry system (Santa Clara, CA) was used to obtain continuous, "real-time" recordings of temperature monitored at various positions on the patient and metallic components of the cervical fixation devices. This was monitored during the use of various types of pulse sequences.

Because there was the presumed likelihood of vibrations occurring during MR procedures in patients with a cervical fixations devices, a motion-sensitive laser-Doppler blood flow monitor probe (Vasomed, Minneapolis, MN) was applied to the forehead of the subject, such that the edge of the probe abutted one of the skull pins to detect possible vibrations during MRI.

The subject had no complaints of discomfort or unusual sensations during the use of the conventional pulse sequences for MRI while wearing the various cervical fixation devices. However, the subject did complain of a sensation of "heating" during the use of a three-dimensional, gradient-echo, magnetization transfer contrast pulse sequence. There were no temperature increases greater than 1.1°C measured by any of the thermometry probes during the use of the various pulse sequences. The skin sites where each of the skull pins contacted the subject's tissue was visually inspected and palpated and seemed to be normal (ie, no redness, no feeling of warmth, etc.).

The recording from the laser-Doppler blood flow monitor was inspected and indicated that there was motion that was greater than that compared with the recordings obtained during the other conventional pulse sequences, suggesting that there were excessive vibrations that coincided with the use of the magnetization transfer contrast technique.

Apparently, using certain imaging parameters and under certain conditions of the MR procedure, sufficient vibrations may occur to create the sensation of heating with the use of MR-compatible cervical fixation devices. This is presumed to occur when the frequency or degree of vibration is at a certain level that

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stimulates peripheral nerve receptors located in the subcutaneous region that detect sensations of pain and temperature changes. The aforementioned merely is a hypothesis based on the available experience and the soon to be published data. Suffice it to say that there are no excessive temperature elevations despite the sensation of heating felt by patients wearing MR-compatible cervical fixation devices during MRI.

Based on the above, we recommend that there be increased awareness of the potential for excessive vibration to occur during MRI when externally applied metallic objects are present. This may be misinterpreted by the patient as a burning or other unusual sensation. To minimize vibration, we recommend shortening the length of the pin that extends from the locking nut to the patient.

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