

## [ Primary Care ]

# Tattoo-Induced Skin “Burn” During Magnetic Resonance Imaging in a Professional Football Player: A Case Report

James R. Ross, MD, and Matthew J. Matava, MD\*

The authors present the case of a professional football player with an immediate and sustained cutaneous reaction (“burn”) at the site of lower extremity tattoos that occurred during magnetic resonance imaging of the pelvis. The burn was attributed to an electromagnetic reaction due to the ferromagnetic metallic compounds found in tattoo pigments, especially iron oxide—a reaction that has the potential to distort the field of image. These compounds can theoretically create an electric current that increases the local skin temperature, enough to cause a cutaneous burn. “At risk” tattoos are those with black pigment or any other pigments containing iron oxide, as well as those with a design that displays loops, large circular objects, or multiple adjacent points. Patients who develop this reaction may be treated prophylactically or symptomatically with a cold compress to assist with completion of the examination. Alternatively, a towel or cloth may be placed between the cutaneous body parts in those patients who experience the typical reaction resulting from an electrical arc between 2 separate cutaneous tattoos. This is likely an underreported issue that merits mention in the sports medicine literature given the frequent occurrence of cosmetic tattoos in athletes requiring magnetic resonance imaging to diagnose a musculoskeletal injury. As in the present patient, no permanent sequelae have been noted in the literature. Therefore, patients who develop this reaction should be reassured that the reaction is only temporary.

**T**raditional and cosmetic tattoos have been performed for thousands of years both in the United States and around the world. The Food and Drug Administration considers the inks used in intradermal tattoos, including permanent makeup, to be cosmetics, and it considers the pigments used in the inks to be color additives requiring premarket approval under the federal Food, Drug, and Cosmetic Act.<sup>10</sup> The administration, however, has not exercised its authority over tattoo inks or pigments because of other public health priorities and a previous lack of evidence of safety concerns. The actual practice of tattooing is regulated by local jurisdictions.

Magnetic resonance imaging (MRI) is a frequently used imaging modality for the analysis of soft tissue injuries and is generally considered a safe procedure. Nearly 70% of American football players presenting to the 2010 National Football League National Invitational Camp (ie, NFL Scouting Combine) reported that they previously underwent MRI for a variety of musculoskeletal injuries. Unfortunately, there is confusion in regard to the safety of an individual with a tattoo who must

undergo this imaging modality, because of the presence of ferrous compounds present in the tattoo ink. Considering that MRI uses magnetic energy to generate its images, the potential exists for an electromagnetic reaction to occur in the cutaneous area containing a tattoo. There have been documented case reports of tattoos causing not only imaging artifacts but also minor cutaneous reactions.<sup>3,11,12</sup>

We present the case of a patient with an immediate and sustained cutaneous reaction at the site of lower extremity tattoos that occurred during MRI. This appears to be an emerging issue given the expanding frequency of tattoos seen in amateur, as well as professional, athletes. The patient was informed that the case would be submitted for publication, and he consented to the submission.

## CASE REPORT

A 24-year-old white male professional American football player in otherwise good general health, standing at 185.4

From the Department of Orthopedic Surgery, Washington University, St Louis, Missouri

\*Address correspondence to Matthew J. Matava, MD, Washington University Orthopedics, 14532 South Outer Forty Dr, Chesterfield, MO 63017 (e-mail: matavam@wudosis.wustl.edu).

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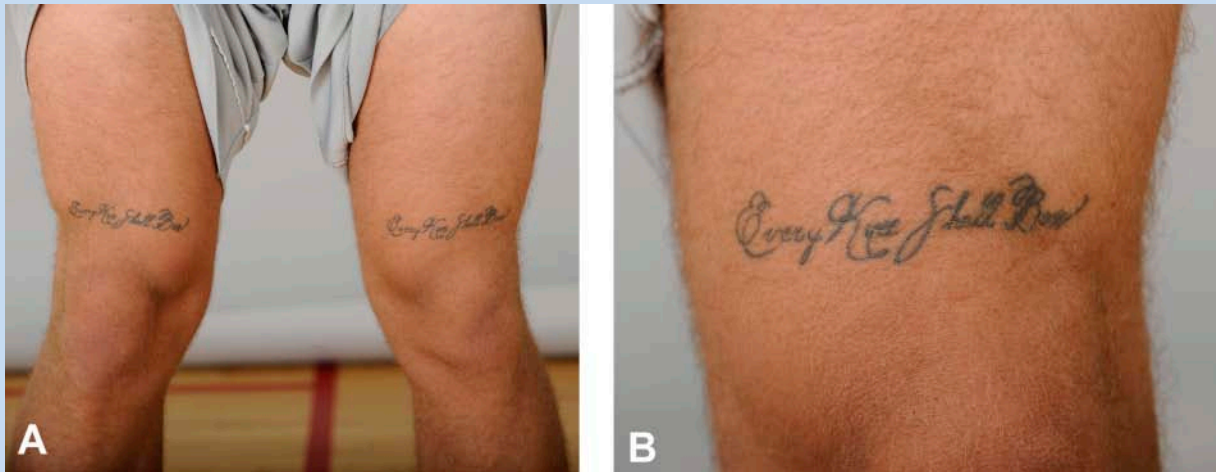


Figure 1. A, clinical image of the patient's bilateral suprapatellar tattoos, which resulted in a localized skin burn during magnetic resonance imaging. B, close-up image of left knee further demonstrating the nature of the tattoos.

cm and weighing 108.4 kg, presented with discomfort in the right proximal hamstring. The patient was an outside linebacker who sustained a grade I proximal hamstring strain 2 months previously for which he underwent MRI without any complications. He reagravated this injury after a hyperextension force to the right lower extremity.

Physical examination revealed normal neurologic and vascular findings in the lower extremity. His gait was antalgic, with the tendency to limit right knee flexion during the swing phase. He had tenderness to palpation over the proximal origin of the hamstrings without any appreciable defect. He demonstrated pain with resisted knee flexion at 30°. The popliteal angle was 45° on the affected side, compared with 10° on the normal, contralateral limb. He had no other areas of tenderness and full, nontender range of motion of the right hip. No dermatologic abnormalities or ecchymosis were noted; however, black-colored cosmetic tattoos were noted over the suprapatellar region of both knees (Figure 1). Upon further inspection and questioning, it was revealed that he had multiple tattoos in various locations over his body that were obtained at different times throughout his life. Tattoos covering the posterior upper arms were obtained in 2004 (left) and 2005 (right). The tattoos over the suprapatellar regions of both knees were obtained in 2008. His final tattoo, over the right flank, was obtained in 2009. All of his tattoos were drawn by professional tattoo artists.

Given the recurrent nature of the injury, the patient was referred for repeat MRI of the pelvis and thigh. He underwent preprocedural medical evaluation and preparation according to the facility's standard protocol. He was positioned supine in the 1.5-T MRI system feet first. MRI of the pelvis was performed using a body-phased array coil, with coronal images (large field of view, short repetition time, short echo

time, and inversion recovery) as well as transverse sequences (short repetition time, short echo time, and fast spin echo, and inversion recovery). Approximately 5 minutes after initiation of the study, the patient began to experience a sudden burning pain over the suprapatellar regions of both knees in the area of his tattoos. This sensation was localized to the knees and not experienced in the areas of the other tattoos. The patient notified the technician immediately, and the examination was interrupted so that his knees could be inspected by the radiologist. A wet towel was placed over and between both knees, and the study was completed. The sensation continued; however, it was present at a lower level that was tolerable. After completion of the study, the patient noted mild swelling and erythema surrounding the tattoos over both knees. This superficial reaction resolved within 12 hours without any evidence of permanent sequelae. Of note, the patient underwent 4 previous MRIs without any symptoms.

## DISCUSSION

The first report of an MRI-induced reaction to a patient's skin containing a tattoo was described by Kredstein et al in 1997.<sup>3</sup> The patient in that report experienced sudden burning pain in the area of an abdominal tattoo, simply in the presence of a static magnetic field upon entrance into the MRI suite. She ultimately underwent excision of the tattooed skin with primary closure of the site to permit completion of the MRI. The authors further confirmed a ferromagnetic property of the tattoo pigment by documenting migration of the ellipsed skin toward a standard horseshoe magnet. They further studied the ferromagnetic properties of common tattoo pigments and showed that iron oxide–based pigments (most commonly black and brown) were displaced by a magnetic field,

whereas carbon-, titanium-, and copper-based pigments were unaffected. Kanal and Shellock<sup>2</sup> responded to this report by recommending that physicians consider placing an ice pack or a cold compress on the tattoo before magnetic resonance examination and to leave it in place until completion. They also recommended a pressure dressing to prevent any tissue distortion. Of course, these conservative measures should be tried before any invasive intervention, such as resection of the tattoo-containing skin.

Following the initial report described above, 2 other cases of cutaneous burns sustained by MRI were described in 2000.<sup>11,12</sup> One patient had a large tattoo (20 × 10 cm) of a dragon with “vivid colors and several loops of the tail and neck.” It has been proposed that tattoos containing electrically conductive material that are applied to the dermis in a loop pattern are those most at risk for a cutaneous reaction. These particular tattoos have the potential to induce an electric current and thus burn the skin following the radiofrequency pulse of the MRI process.<sup>3</sup> Perhaps the combination of the size, ferromagnetic pigment, and loops of the tattoo caused the first-degree burn noted in this reported patient. The second patient sustained a second-degree burn in the right deltoid, in the region of a tattoo consisting of 2 jet-black thunderbolts encircling a Chinese symbol.<sup>12</sup> Interestingly, the skin reaction occurred only over and surrounding the thunderbolts while sparing the central symbol. The supplier of the tattoo ink was contacted, and it was discovered that the dark tattoo ink contained high concentrations of iron oxide, which has been shown to be highly ferromagnetic.<sup>3</sup>

In 2002, Tope and Shellock<sup>9</sup> performed a survey of individuals with tattoos in an effort to determine the incidence of complications and adverse events associated with MRI in the presence of a cosmetic tattoo. They identified 135 patients from 1032 surveys who underwent MRI after having permanent cosmetic tattoos applied. Two (1.5%) reported adverse events, which consisted of a “tingling” and “burning” sensation that resolved upon study completion. Both women had blue-black pigment colors for periorbital tattoos and had undergone MRI of the cervical spine. Five (6%) within this population had previously been denied MRI because of their cosmetic tattoos. As a result of the findings and the small number of case reports published, the authors recommended that patients with tattoos be granted permission to undergo MRI with close observation.

Thermal injuries during MRI procedures have been described, mainly associated with monitoring systems including sensors, cables, or other foreign objects placed on the patient’s skin.<sup>8</sup> These injuries are thought to arise from currents induced within the conductive objects by the MRI coils, creating heat and eventually burns. The demonstration of grossly detectable ferromagnetic characteristics of the tattoos and cosmetics has been described in various journals.<sup>1,4,6,13</sup> These cases have been manifested primarily as image distortion in the area of interest due to a nearby tattoo. MRI involves the use of a strong magnetic field to obtain images of structures within the body. The metallic compounds

found in tattoo pigments, especially iron oxide, distort that field. These compounds can theoretically create an electric current that increases the local skin temperature, enough to cause a cutaneous burn. Simple loops of conductive material have been shown to result in the induction of a large and potentially hazardous voltage in the imaging system.<sup>5</sup> It is highly conceivable that the loop-shaped tattoos in the patient carried a level of voltage significant enough to cause a burn. Alternatively, an arc may have been created from 1 knee to the other given the symmetrical nature of the 2 tattoos and the lack of any cutaneous reaction in the patient’s other tattoos. Self-resonance of such a loop may add greatly to hazards by increasing the effective coupling to the radio frequency transmitter. We contacted the professional tattoo artist who applied the player’s tattoo and, subsequently, the tattoo ink distributor to determine the chemical composition of the black ink that was used. The tattoo ink supplier is based in Japan and could not be contacted, nor were we able to obtain the material safety data sheet or a list of the chemical components.

In consideration of the previous literature pertaining to MRI of patients with cutaneous tattoos, Shellock<sup>7</sup> recommended the following patient management guidelines:

- The screening form used for patients should include a question to identify the presence of permanent cosmetics or decorative tattoos.

- Before undergoing an MR procedure, the patient should be asked if he or she had a permanent coloring technique (ie, tattooing) applied to any part of the body. This includes cosmetic applications such as eyeliner, lip-liner, lip coloring, as well as decorative designs.

- The patient should be informed of the risks associated with the site of the tattoo.

- The patient should be advised to immediately inform the MRI technologist regarding any unusual sensation felt at the site of the tattoo in association with the MR procedure.

- The patient should be closely monitored using visual and auditory means throughout the operation of the MR system to ensure safety.

- As a precautionary measure, a cold compress (eg, wet washcloth) may be applied to the tattoo site during the MR procedure.

In summary, the patient with a cosmetic tattoo should be permitted to undergo MRI despite the rare possibility of a cutaneous reaction manifested most commonly as a low-grade burn. It is, however, important to identify tattoos that are “at risk,” such as those with black pigment or any other pigments containing iron oxide, as well as those with a design that displays loops, large circular objects, or multiple adjacent points. These patients may be treated prophylactically or symptomatically with a cold compress to assist with completion of the examination. Alternatively, a towel or cloth may be placed between the cutaneous body parts in those patients

who experience the typical reaction resulting from an electrical arc between 2 separate cutaneous tattoos.

We present the case of a National Football League football player who experienced burning pain in the areas of his cosmetic tattoos, which was not responsive to the placement of interpositional material between each knee that had the tattoos. This is likely an underreported issue that merits mention in the sports medicine literature given the frequent occurrence of cosmetic tattoos in athletes requiring MRI to diagnose a musculoskeletal injury. No permanent sequelae have been noted. Therefore, patients who develop this reaction should be reassured that the reaction is only temporary.

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