Magnetic Resonance Imaging and Permanent Cosmetics (Tattoos): Survey of Complications and Adverse Events

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**Purpose:** To use a survey to determine the incidence of complications and adverse events in individuals with permanent cosmetics (e.g., tattooed eyeliner, eyebrows, lips, cheeks, etc.) who underwent magnetic resonance (MR) imaging.

**Materials and Methods:** A questionnaire was distributed to clients of cosmetic tattoo technicians. This survey asked study subjects for demographic data, information about their tattoos, and for their experiences during MR imaging procedures.

**Results:** Data obtained from 1032 surveys were tabulated. One hundred thirty-five (13.1%) study subjects underwent MR imaging after having permanent cosmetics applied. Of these, only two individuals (1.5%) experienced problems associated with MR imaging. One subject reported a sensation of “slight tingling” and the other subject reported a sensation of “burning”; both sensations were transient in nature.

**Conclusion:** Based on these findings and information in the peer-reviewed literature, it appears that MR imaging may be performed in patients with permanent cosmetics without any serious soft tissue reactions or adverse events. Therefore, the presence of permanent cosmetics should not prevent a patient from undergoing MR imaging.

**Key words:** magnetic resonance imaging, safety; magnetic resonance imaging, bioeffects; heating; artifacts; magnetic resonance imaging


TRADITIONAL (I.E., DECORATIVE) and cosmetic tattooing have been performed for thousands of years. In the United States, cosmetic tattooing or “permanent cosmetics” are used to reshape, recolor, recreate, or modify eye shadow, eyeliner, eyebrows, lips, beauty marks, and cheek blush (1). Additionally, permanent cosmetics are often used aesthetically to enhance nipple-areola reconstruction (2).

Magnetic resonance (MR) imaging is a frequently used imaging modality, particularly for evaluating the brain, head, neck, and other anatomic regions where cosmetic tattoos are typically applied. Unfortunately, there is much confusion regarding MR safety aspects of permanent cosmetics (3–6). For example, based on a few reports of symptoms localized to the tattooed area during MR imaging, many radiologists have refused to perform MR procedures on individuals with permanent cosmetics, particularly tattooed eyeliner (unpublished observations, F. G. Shellock, 2000). Obviously, this undue concern for possible adverse events prevents patients with cosmetic tattoos from access to an extremely important diagnostic imaging technique.

While it is well-known that cosmetic tattoos may cause MR imaging artifacts (3–11) and that both cosmetic and decorative tattoos may cause relatively minor, short-term cutaneous reactions (3,8,11–16), the frequency and severity of soft tissue reactions or other related problems associated with MR imaging and cosmetic tattoos is unknown. Therefore, the purpose of this investigation was to determine the frequency and severity of adverse events associated with MR imaging in a population of subjects with permanent cosmetics.

**MATERIALS AND METHODS**

A questionnaire was developed to survey individuals with permanent cosmetics to determine the incidence and severity of complications or adverse events associated with MR imaging. The questionnaire asked study subjects for basic demographic data, information about their cosmetic tattoos, information about their MR imaging examinations, and their experiences with these procedures relative to the permanent cosmetics. Table 1 shows the questionnaire used in this investigation.

The questionnaire was distributed in the United States to clients of permanent cosmetic technicians who were members of the Society of Permanent Cosmetic Professionals (SPCP, an international, non-profit organization of cosmetic tattoo artists). This permitted individuals with cosmetic tattoos to be contacted con-
RESULTS

Of a total of 3065 questionnaires that were distributed, 1037 (34%) were returned for analysis. Five surveys contained insufficient data for inclusion (i.e., the answers were incomplete), leaving a total of 1032 questionnaires available for tabulation. The majority (1027; 99.5%) of the study subjects with permanent cosmetics were women. The ages of these individuals ranged from 14 to 93 years old. Caucasians formed the largest racial population (961; 93%) for the respondents (14 [1%] Asian; 16 [2%] Latino; six [1%] African-American; two [0.2%] Native American; 30 [3%] data not provided).

Eight hundred ninety-seven (897/1032; 87%) study subjects with permanent cosmetics reported that they never had MR imaging examinations (Non-MRI Group), while 135 (135/1032; 13%) study subjects underwent MR imaging after application of permanent cosmetics (MRI Group). The mean age of the Non-MRI Group (50 ± 5 years old) was significantly younger (P < 0.05) than that of the MRI Group (56 ± 5 years old). For the Non-MRI Group, five study subjects (6%) reported that the MR facility personnel or radiologists would not allow them to have MR imaging procedures due to potential complications with cosmetic tattoos.

For the MRI Group (N = 135), tattoo site information was available in 131 subjects (97%). These subjects reported a total of 210 individual tattoos (i.e., 61 subjects, 45%, had more than one cosmetic tattoo). Of these, 210 permanent cosmetics were applied to the following body sites: 85 (41%) eyelid, 75 (36%) eyebrow, 34 (16%) lip, six (3%) cheek, four (2%) areola, and six (3%) trunk.

Information on tattoo pigment color was available for 112 of the 135 (83%) study subjects in the MRI Group. Notably, 91 of these study subjects (67%) reported that they had permanent cosmetics that were applied using pigment colors (e.g., brown, black, red, and flesh) that typically contain iron oxide.

For the MRI Group (N = 135), information on the cosmetic tattoos and body sites for the MR imaging examinations was available for 133 (98%) of the subjects and is shown in Table 2. Forty of these subjects had MR imaging examinations involving more than one anatomic region (i.e., for a total of 173 MR imaging examinations). Fifty-six (42%) of the subjects in the MRI Group had MR imaging examinations that involved the immediate anatomic site where the permanent cosmetic was applied (Table 2).

One hundred thirty-three (133/135, 98.5%) of the MRI Group reported that there were no complications, adverse events, or other problems associated with MR imaging. Two (2/135, 1.5%) study subjects in the MRI Group reported complications or adverse events associated with MR imaging. One subject experienced “slight tingling” before MR imaging began and the other subject reported a “burning” sensation that started before entering the magnet (i.e., while in the MR system room, in the MR environment) that resolved by the end of the examination. Both of these subjects were women who had blue-black pigment colors used for peri-orbital (i.e., eyelid/eyeliner) tattoos and underwent MR imaging of the cervical spine. Each tattoo had been applied at least nine months prior to the MR imaging examination. In neither case did the severity of symptoms warrant cessation of the MR imaging. Neither subject reported any other problem with the tattooed areas (e.g., erythema, edema, irritation, etc.) subsequent to MR imaging.

To gather as much information as possible, it will be important to contact your radiologist about your MRI scan and permanent cosmetic technician about your cosmetic tattoo. To do this, we will need the following information. If you do not wish to release this information, simply leave the spaces blank. Thank you for your cooperation.

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According to the findings of our study, there was an extremely low incidence (1.5%) of complications or adverse events, and the severity of these problems was relatively minor (i.e., there was no serious, permanent, or life-threatening injury). Of interest is that, for these study subjects, one individual reported a “burning sensation” that was unrelated to the actual scanning procedure (i.e., upon entering the MR environment), while the other subject’s symptom, a “tingling sensation”, has not been previously reported. Importantly, neither problem prevented completion of the MR imaging procedure.

Investigations of incidents related to patients experiencing cutaneous or other reactions in relation to the presence of both cosmetic and decorative tattoos revealed that there was a tendency for these problems to occur whenever pigments that contained iron oxide or other similar metallic substance(s) were used (3–16). The study subject that reported a “burning sensation” had her cosmetic tattoo applied by an ophthalmologist using black pigment that typically contains iron oxide. Unfortunately, the exact type of pigment that was used could not be verified and there tends to be little quality control over tattoo ink (15). Apparently, certain ferrous pigments used for the tattooing process can interact with the electromagnetic fields used for MR procedures, producing the reported problems (7–11, 13, 16).

Proposed mechanisms to explain tattoo-related problems encountered in the MR environment include magnetic field related interactions and/or radiofrequency (RF)-induced induction of heating. The fact that an individual in this study reported symptoms even before entering the MR system suggests that one possible causative factor is the static magnetic field. Presumably, traction or torque from interaction of the ferromagnetic tattoo particles with the static magnetic field may be partially responsible for the symptoms reported.

In a letter to the editor that described a second-degree burn that occurred on the skin of the deltoid from a decorative tattoo, the authors suggested that “the heating could have come either from oscillations of the gradients or, more likely from the RF-induced electrical currents” (15). However, the exact mechanism(s) responsible for complications or adverse events in the various cases that have occurred is unknown.

Interestingly, decorative tattoos tend to cause worse problems (including first- and second-degree burns) for patients undergoing MR imaging compared to those who have been reported for cosmetic tattoos (6–13, 15, 16). For example, a recent publication reported that a patient experienced a sudden burning pain at the site of a decorative tattoo while undergoing MR imaging of the lumbar spine using a 1.5-Tesla MR system (13). Swelling and erythema resolved within 12 hours, without evidence of permanent sequelae. The tattoo pigment used in this case was ferromagnetic, which possibly explains the symptoms experienced by the patient. Surprisingly, in order to permit completion of the MR examination, an excision of the tattooed skin with primary closure of the site was performed (13).

The authors of this report stated, “Theoretically, the application of a pressure dressing of the tattoo may

### DISCUSSION

The incidence of complications or adverse reactions and severity of these problems for patients with permanent cosmetics undergoing MR imaging examinations are unknown. Unfortunately, many MR healthcare professionals do not fully understand the relative risk of performing MR imaging in patients with permanent cosmetics and, as such, may not allow these patients to undergo examinations. (For example, findings from this survey revealed that 6% of the study subjects with permanent cosmetics were not allowed to undergo MR imaging because of MR safety concerns.) Therefore, the purpose of this investigation was to determine the frequency and severity of problems associated with MR imaging in a selected population of subjects with permanent cosmetics with the intent of providing guidance and recommendations based on the results of this study and those published in the peer-reviewed literature.

To date, only a small number of patients (estimated to be less than 10) that have undergone MR imaging have reported transient symptoms that included skin irritation, cutaneous swelling, or a heating sensation at the site of application of the permanent cosmetics (review of Medical Device Reports, 1985 to 1999). Because of these incidents, the latest MR safety recommendations and guidance from the Food and Drug Administration (Guidance for Industry Guidance for the Submission of Premarket Notifications for Magnetic Resonance Diagnostic Devices) states that the performance of an MR imaging examination requires particular caution for “patients with permanent (tattoo) eye-liner or with facial make-up” (17).

### Table 2

<table>
<thead>
<tr>
<th>Anatomic Site</th>
<th>No. of MR Imaging Examinations</th>
<th>Complication/Adverse Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Eye/orbit</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Abdomen</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Lower extremity</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Spineb</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Back</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Pelvis</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Total bodyc</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Site not indicated</td>
<td>2</td>
<td></td>
</tr>
</tbody>
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<th>Anatomic Sited</th>
<th>No. of MR Imaging Examinations</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>1</td>
<td>Slight tingling</td>
</tr>
<tr>
<td>Neck</td>
<td>1</td>
<td>Burning</td>
</tr>
</tbody>
</table>

Subjects with permanent cosmetics that did not have adverse reactions (number of subjects, 133; total number of MR imaging anatomic sites, 173).

*Spine refers to cervical, thoracic and lumbar spine MR imaging examinations.

Total body was the term used by the subjects to describe their examinations.

Subjects with permanent cosmetics that had a complication or adverse event (number or subjects, 2).
prevent any tissue distortion due to ferromagnetic pull (13). However, this simple, relatively benign procedure was not attempted for this patient. They also indicated that, “In some cases, removal of the tattoo may be the most practical means of allowing MRI” (13).

Kanal and Shellock (14) commented on this report in a letter to the editor, suggesting that the response to this situation was “rather aggressive”. Clearly the trauma, expense, and morbidity associated with excision of a tattoo far exceed those that may be associated with ferromagnetic tattoo interactions. A firmly applied pressure bandage may be used if there is any concern related to “movement” of the ferromagnetic particles in the tattoo pigment (14). Additionally, direct application of a cold compress to the site of a tattoo would also likely mitigate any heating sensation that may occur in association with MR imaging.

A comprehensive search of the peer-reviewed literature supports the results of this present investigation (8–10). That is, symptoms rarely occur, the symptoms are transient in nature, and the severity of the symptoms is relatively minor. Furthermore, when one considers the many millions of clinical MR procedures that have been conducted in patients over the past 15 years and that only a very small percentage of these individuals have had minor, short-term problems related to the presence of permanent cosmetics, it is apparent that this MR safety concern has an extremely low rate of occurrence and relatively insignificant consequences.

With regard to artifacts, none of the study subjects in this investigation were informed that the MR images were substandard due to the presence of tattoos and none of the examinations had to be repeated. Nevertheless, imaging artifacts associated with permanent cosmetics have been reported (7–10). These artifacts are predominantly associated with the presence of pigments that use iron oxide and occur in the immediate area of the tattoo. As such, tattoo-related MR imaging artifacts should not prevent a diagnostically adequate MR imaging procedure from being performed, especially in consideration that careful selection of imaging parameters may easily minimize artifacts related to metallic objects (3,4).

The only possible exception to this is if the anatomy of interest is in the exact same position of where the tattoo was applied using an iron oxide-based pigment. For example, Weiss et al (7) reported that heavy metal particles used in the pigment base of mascara and eyelining tattoos cause alterations of the local magnetic field in adjacent tissues. These changes in normal signal may result in distortion of the globes. In some cases, the distortion may mimic actual ocular disease, such as a ciliary body melanoma or cyst.

This investigation has possible limitations. For example, precise MR imaging details that may influence complications or adverse events in patients with cosmetic tattoos were unknown (i.e., static magnetic field strength of the MR system, imaging parameters, type of RF coil, RF power deposition, etc.). Given the limitations of MR imaging knowledge held by the respondents to this survey, this lack of information is understandable; however, we believe that it can be safely assumed that the subjects in this investigation underwent MR imaging procedures using standard, MR imaging techniques and procedures. Additionally, it would be advantageous to evaluate additional subjects with both cosmetic and decorative tattoos that undergo MR imaging. Thus, additional research that acquires specific MR imaging information in a larger group of tattooed subjects is warranted. This may help determine a mechanism responsible for the cutaneous reactions that sometime occur in the MR setting.

In consideration of the findings of this study and the available literature pertaining to MR imaging and patients with cosmetic tattoos, the following patient management guidelines are recommended:

1. The Pre-MR Procedure Screening Form should include a question pertaining to the presence of permanent cosmetics or decorative tattoos (3–5).
2. Before undergoing an MR imaging examination, the patient should be asked if he or she has a permanent coloring technique (i.e., tattooing) applied to any part of the body. This includes cosmetic applications such as eyeliner, lip-liner, lip coloring, and decorative designs.
3. The patient should be informed of the relatively minor risk associated with the site of the tattoo.
4. The patient should be advised to immediately inform the MR technologist regarding any unusual sensation felt at the site of the tattoo in association with the MR imaging procedure.
5. The patient should be closely monitored using visual and auditory means throughout the entire operation of the MR system to ensure safety.
6. As a precautionary measure, a cold compress (e.g., wet wash cloth) may be applied to the tattoo site during the MR imaging procedure.

In conclusion, because of the relatively remote possibility of having an incident occur in a patient with a permanent cosmetic and due to the relatively minor short-term complication or adverse event that may develop (i.e., transient cutaneous redness and swelling), the patient should be permitted to undergo MR imaging. Any problem of performing an MR imaging procedure in a patient that has a cosmetic tattoo is unlikely to prevent the examination, since the important diagnostic information that is provided by this imaging modality is typically critical to the care and management of the patient.

REFERENCES
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