

## SAFETY OF TATTOOS IN MRI: AN INTERIM REPORT ON A PROSPECTIVE STUDY

Nikolaus Weiskopf<sup>1</sup>, David Bradbury<sup>1</sup>, Sheila Burns<sup>1</sup>, and Janice Glensman<sup>1</sup>

<sup>1</sup>Wellcome Trust Centre for Neuroimaging, University College London, London, United Kingdom

**Target audience:** Researchers and clinicians who scan human volunteers and patients with tattoos.

**Purpose:** The goal of this study is to establish whether tattoos increase the risk of an adverse reaction while undergoing an MRI scan and to determine potential risk factors. So far, only anecdotal reports of adverse reactions (e.g. <sup>1-4</sup>) and a single retrospective survey <sup>5</sup> related to tattoos were published. Due to the scarcity of studies, safety guidelines are still contradictory, particularly, for scanning healthy volunteers in a research setting. We have initiated a prospective study of all healthy volunteers with tattoos scanned at our lab and report on the interim results based on 127 volunteers.

**Methods:** All healthy volunteers who participated in an MRI neuroimaging experiment at our lab and had one or more tattoos were also included in this safety study with written informed consent (approved by the local Ethics Committee). Volunteers were systematically checked for MRI contraindications (e.g., active implants). To further minimize any potential risk, volunteers with a) tattoos in the head/neck/genital area, b) tattoos covering more than 5% total body area, c) a single tattoo larger than 20 cm, or d) with thermoregulatory problems were excluded and not scanned. Volunteers were scanned at 3T (Magnetom TIM Trio or Allegra; Siemens Healthcare) using radio-frequency (RF) body or head transmit coils.

The following characteristics of the tattoo(s) were recorded prior to scanning: color, type of ink, tattoo studio with location, maximal/minimal extent, location on body and whether covered by clothes. Information about the volunteers included age and sex. The scanner type, RF coil type and maximal specific absorption rate (SAR) were also registered. Any adverse event or report of discomfort was documented and followed up. Classification of the adverse event included besides others a causality assessment, severity and expectedness, which determined whether the adverse event was categorized as an adverse reaction due to the tattoo. The 95% confidence interval (CI) for the probability of an adverse reaction was estimated from its frequency (Clopper-Pearson as implemented in Matlab).

**Results:** So far, 127 healthy volunteers (90 female, age 28±9 yrs [mean±sd]) were recruited over the period of ca. 2 years. Fifteen volunteers were scanned with a head transmit RF coil and 24 had multiple tattoos. The average maximal/minimal extent of the tattoos was 8.5±5.0 cm/4.6±2.9 cm. The most frequent tattoo colors were black, blue, white and yellow and present in 94%, 10%, 9% and 9% of all cases. Tattoos were located on almost all body areas. The maximal SAR averaged across volunteers was 35%±15% of the normal scanning mode SAR threshold. Two volunteers reported sensations, which were classified as not related to the tattoo (e.g., peripheral nerve stimulation), i.e., they were not classified as an adverse reaction. One volunteer reported a warm and tight feeling around the tattoo, which was classified as a tattoo related mild adverse reaction and resolved with no residual effects. The probability of an adverse reaction was estimated to be lower than 4.5% (95% CI, Clopper-Pearson) based on one adverse reaction in 127 volunteers.

**Discussion:** One tattoo related adverse reaction was observed in 127 volunteers, limiting the estimated probability of an adverse reaction to less than 4.5%. This prospective study avoids several potential confounds of the previously used study designs, but it is still limited in its conclusions due to the specific sampling of the population and additional safety precautions taken. We have only sampled from the population of healthy participants volunteering for MRI neuroimaging experiments at our lab. The sample is not representative of the UK's general population (but possibly of volunteers studied in neuroimaging research). The characteristics of the tattoo may influence the risk. However, tattoos and tattoo inks are not well regulated or defined and vary widely, e.g., colors and shapes.

**Conclusion:** Since only one mild adverse reaction was observed in 127 volunteers, it suggests that the additional risk due to tattoos in MRI is relatively low (estimated probability < 4.5%). Although this is the first *prospective* study on safety of tattoos in MRI avoiding several potential confounds of previous studies, the particular group of volunteers studied may still limit general conclusions. We have also applied additional precautions to minimize the risk (e.g., limits on the size of the tattoo).

### References:

1. Kreidstein, M.L. *et al. Plast. Reconstr. Surg* **99**, 1717 (1997).
2. Wagle, W.A. *et al. AJR Am J Roentgenol* **174**, 1795 (2000).
3. Ratnapalan, S. *et al. AJR Am J Roentgenol* **183**, 541 (2004).
4. Franiel, T. *et al. AJR Am J Roentgenol* **187**, W556 (2006).
5. Tope, W.D. *et al. J Magn Reson Imaging* **15**, 180 (2002).

**Acknowledgements:** This study was supported by the Wellcome Trust.