

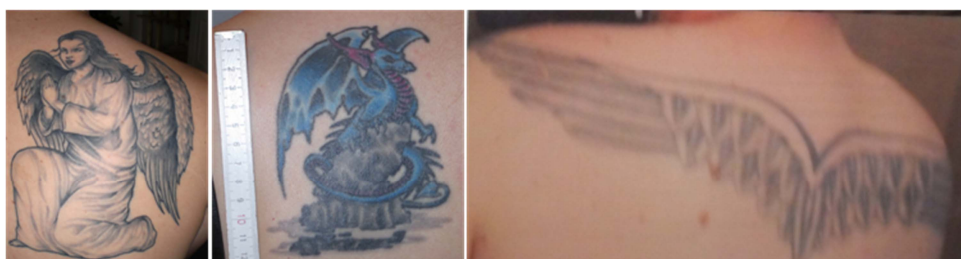
## Imaging healthy volunteers and patients with tattoos or permanent make-up at 7T: A retrospective study

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**Introduction:** Over the last decade, the number of in vivo MRI studies at 7T has increased dramatically, and recent results in neuroimaging indicate that this field strength will probably become a diagnostic modality in the near future. However, as 7T MRI is currently not medically indicated and as ultra-high-field (UHF) sites tend to be (rightly) very cautious and conservative with respect to the higher RF resonance frequency, the general question of possible contraindications for a 7T scan is regularly discussed. One topic, even at clinical field strengths, is whether a tattoo should be considered as a contraindication or not. Especially tattoos older than 20 years or those that have been made in Asia, as well as black and red inks in general, are suspected to include iron oxide and other metals to a high degree <sup>1</sup>. While some of the reported incidents at clinical field strengths with RF-induced skin burns <sup>2,3,4,5,6,7,8</sup> or skin irritations induced by torques and attractive forces on ferromagnetic particles <sup>9,10</sup> were related to tattoos or permanent make-up, there is also a strong, general history of safe use in imaging patients with tattoos up to 3T <sup>11</sup>. Artistic tattoos and permanent make-up have become mainstream and are increasingly encountered in healthy volunteers and patients to be included in MRI studies. This study presents our experience in imaging patients and healthy volunteers with tattoos at 7T.

**Material and Methods:** Over the last six years, 76 patients and healthy volunteers with tattoos and one with permanent make-up at the eyebrows underwent 7T imaging (Magnetom 7T, Siemens Healthcare) using local transmit RF coils only. Of these 77 subjects, aged between 22 and 64, 64 had their tattoos at least 30



**Fig. 1:** Three examples of tattoos close to the examination FOV. The tattoo on the right was drawn in Thailand and had a width of approx. 40 cm.

cm away from the RF coil. 13 had their tattoos close to but not within the RF coil and hence field-of-view (FOV) of the examination, i.e. the tattoo was at the shoulder while the subject was imaged at the head. These subjects were questioned regarding the origin of the tattoo and if possible regarding the composition of the ink. Twelve of these tattoos were drawn in Germany and one in Thailand, which had a maximum size of roughly 10 by 40 cm as shown in Fig. 1. All patients with their tattoo close to the FOV underwent a head scan: 7 of them had their tattoo on the upper part of the back, 5 on the shoulder, and one on the upper part of the chest. 7 of those subjects were scanned with an 8-channel loop coil (Rapid Biomed, Germany), 5 were scanned with a CP birdcage transmit coil with a 32-channel receive array (Nova Medical, NY), and one with a CP birdcage coil (Invivo Corp., FL). The subject with permanent make-up at the eyebrows was imaged at the liver using a custom-built RF coil for abdominal imaging. However, this subject was not cleared for a head scan at 7T because of the known, typical presence of iron oxide (between 7 and 25%) in the pigment of the permanent make-up. MPRAGE was the most common sequence used in the examinations, and other sequences such as EPI, SWI, TSE and FLASH were used depending on the scope of the study. The total acquisition time ranged between 40 and 164 minutes.

**Results:** None of the subjects reported a heat sensation or discomfort at the tattoos when entering the MR room or during or after the measurements. Furthermore, no reddening was visible at the region of the tattoos after imaging.

**Discussion & Conclusion:** The reported incidents at clinical field strengths give reason to carefully consider whether a subject with a tattoo or permanent make-up should be cleared for a specific MRI scan at 7T or not, particularly since 7T is not yet cleared for medical diagnosis, so there is no direct benefit to the individual. In contrast to 1.5 or 3T, however, only local RF transmit coils are currently used at 7T, making RF field interactions with potentially metallic compositions of tattoo ink less probable under the circumstances presented here, although the higher resonance frequency at 7T may at first suggest the contrary. The general history of safe use in imaging thousands of patients with tattoos at clinical field strengths and our initial experience at 7T indicate that an overly conservative exclusion of subjects with tattoos from 7T scans is not warranted.

[1] Timko, Arch Dermatol. 2001;137(2):143-147.

[4] Klitscher, Der Unfallchirurg vol. 108 issue 5 May 2005. p. 410 - 414

[7] Wagle, AJR June 2000 vol. 174 no. 6 1795

[10] Kreidstein, Plast Reconstr Surg 1997;99:1717-1720.

[2] Ross, Sports Health. 2011Sep;3(5):431-4

[5] Wagner, Fortschr Röntgenstr 2006; 178(7): 728-730

[8] Vahlensieck, Euro. Radio. January 2000, Volume 10, Issue 1, p 197

[11] Tope, J Magn Reson Imaging 15:180-184 (2002)

[3] Offrey, J Fr Ophtalmol. 2009 Feb; 32(2):131.e1-3.

[6] Franiel, AJR November 2006 vol. 187 no. 5 W556

[9] Kanal, Plast Reconstr Surg. 1998 Apr;101(4):1150-1.