Performance of the ASTM-phantom at 3T

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Introduction

For Magnetic Resonance (MR) compatibility and safety measurements often the ASTM-phantom (1) is used. For 1.5T the phantom is established but at 3T the phantom might not be suitable to represent a human of 166 cm and 72 kg as intended. In order to test the performance of the ASTM phantom, maximum SAR measurements were performed on the phantom at 1.5T and 3T and compared to measurements on humans of different height and weight.

Material and Methods

Ten healthy volunteers (3 normal weighted females, 5 normal weighted males, 1 over-weighted male, 1 obese male) and the ASTM-phantom (representing an over weighted person) were scanned on a 1.5T and a 3T whole body MR scanner (Achieva, Philips Medical Systems, Best, NL). The measurements were performed with the body coil at ten different locations 11 cm apart from the nose to the thigh, in the isocenter of the magnet. A TSE sequence was used with the following parameters (1.5T/3T): TSE-factor: 16, TE: 6ms, TR: 130/ 601ms, flip angle: 90°, whole-body SAR: 4/0.9 W/kg, scan duration: 40 sec, avg. $B1^2$: 20.5/2.7μT^2. The load and the forward average power (FAP in W) were extracted from the log-file for each scan.

Results

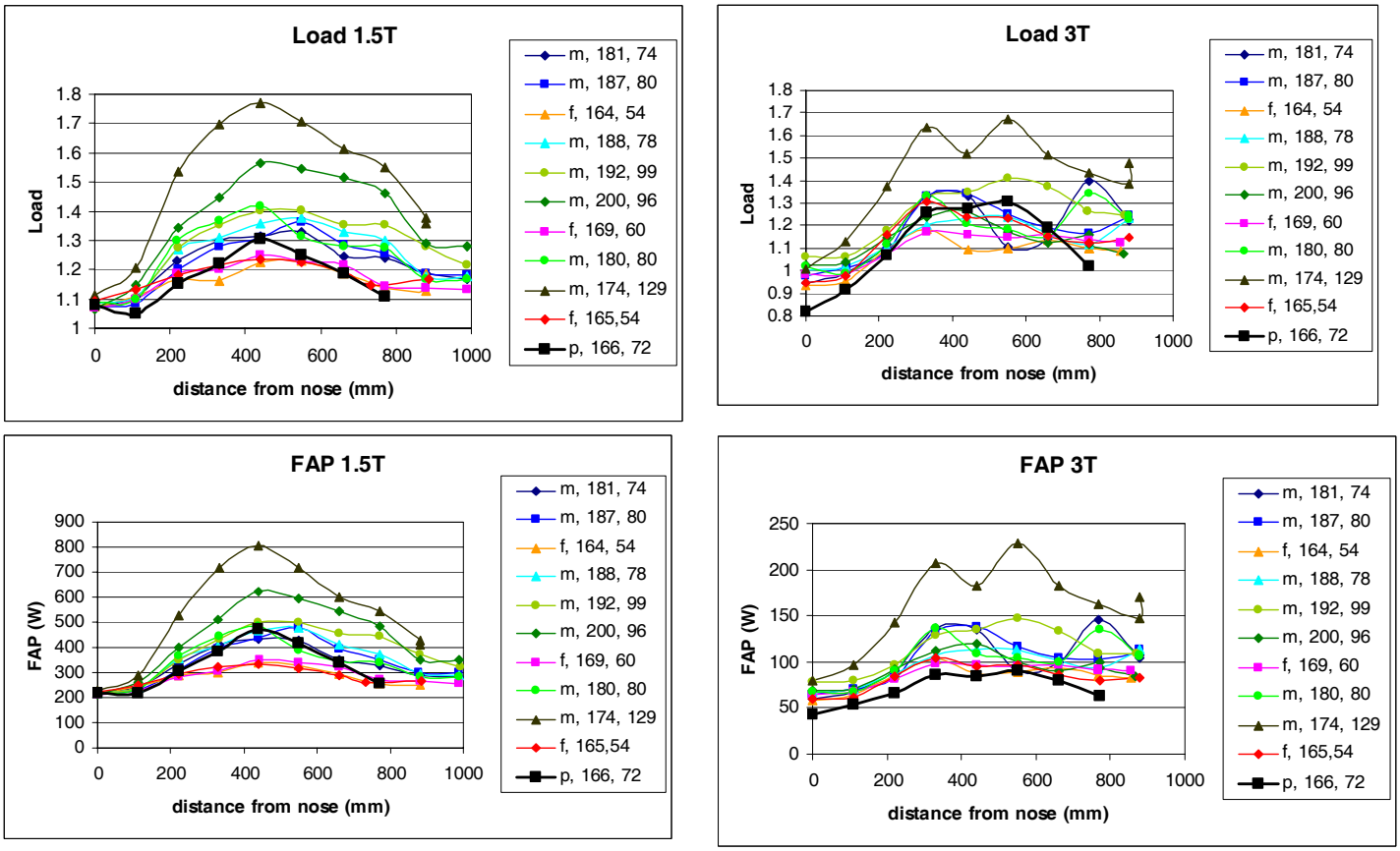

Figure 1: Load and FAP for males (m), females (f) and the phantom (p). The height is indicated in cm, the weight in kg. For both systems, load and FAP are biggest at the location of the thorax and the belly and smaller for the head and thighs. At 1.5T load and FAP of the phantom match well with those of the normal weighted persons. At 3T only the load matches whereas the FAP of the phantom is even smaller than the FAPs in the normal weighted females. The maximum FAP at 3T is 146 W in the male corresponding to the weight of the phantom (74kg, 181cm), 105 W in the female corresponding to the height of the phantom (165cm, 54kg) and only 90 W in the phantom itself.

Discussion

Even though the ASTM-phantom gives an appropriate load at 3T, the deposited power is too small for the person which should be represented by the phantom. This might be the case because of dielectric resonances, which could also be observed on the images. The dimensions of the phantom might be unfavorable for the wavelength at 3T of 19 - 27 cm. MR-safety tests for implants at 3T might underestimate the potential heating when a phantom producing dielectric resonances is used, because only a reduced amount of power can be deposited in this phantom.

References

1: American Society for Testing and Materials. Standard test method for measurement of radio frequency induced heating near passive implants during magnetic resonance imaging. West Conshohocken, PA: ASTM International;2002.