

## Subjective acceptance of ultra-high-field MR imaging at 7T in 573 volunteers

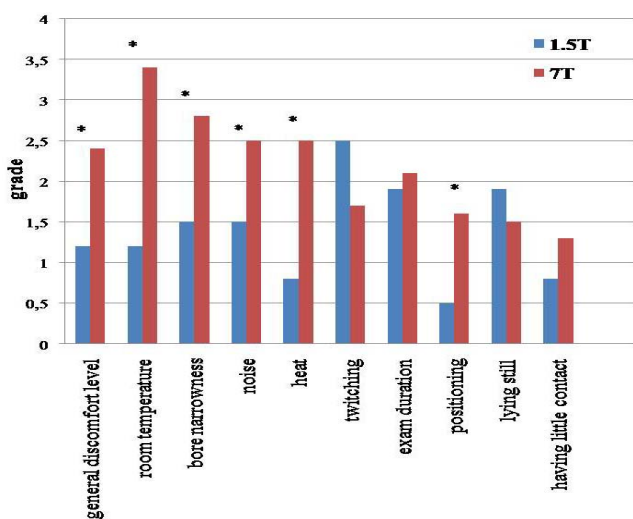
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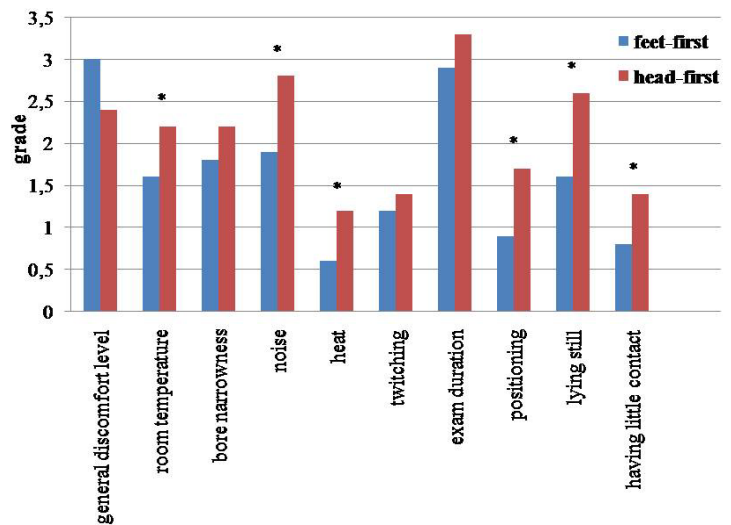
**Purpose:** Research on ultra-high-field magnetic resonance imaging (MRI) (> 3T) is increasing, bringing up the question of the subjective acceptance of this procedure in volunteers. After having gained first experiences on a relatively small number of volunteers at 7T, the aim of this study was to get more insight into the subjective acceptance of this examination in a large study population after technical improvements of the soft- and hardware of the scanner. These results are a precondition to possibly transfer ultra-high-field imaging from a purely scientific examination into a clinical diagnostic tool.

**Methods:** A total of 573 volunteers were enrolled in the study group and were examined on our clinically oriented research site in cooperation with a university hospital. All scans were performed on a 7T machine (Magnetom 7T, Siemens Healthcare Sector, Erlangen, Germany) equipped with a gradient system capable of 45 mT/m maximum amplitude and a slew rate of 220 mT/m/ms, and with bore dimensions of 60 cm in diameter and 3.5 m in length. To reduce side-effects as much as possible the non-motorized patient table was slowly moved into the bore by hand, and communication with as well as supervision of the volunteers were ensured through a two-way speaker system, an emergency squeeze-ball, or a physician inside the scanner room. Most of the 573 volunteers underwent examinations of the head (n= 438), of the lower (n= 79) or of the upper extremity (n= 27) and 166 of them were additionally examined on a 1.5T scanner for comparison of possible field strength effects. After data acquisition the volunteers were asked to fill out an extensive questionnaire with the help of a physician, covering a wide range of possible sensations and side effects. The questionnaire was separated into several sections differentiating between the time during the preparation process inside the scanner room, during the move into or out of the bore as well as during active imaging. All potential side effects had to be rated on an 11-point-scale (0= not unpleasant at all, 5=tolerable, and 10=very unpleasant). Comparisons were performed between the genders, between individuals positioned “head-first” or “feet-first” as well as between the 1.5T- and 7T-examination (paired). For statistical analysis Mann-Whitney *U*-tests and Wilcoxon rank tests were applied.

**Results:** In 6 of the 573 subjects the examination had to be terminated prematurely due to nausea that did not subside. However, in general the 7T-examination was well tolerated (average grade: 2.5; at 1.5T: 1.2) with only 68 people of the study population rating the 7T-scan to be an unpleasant procedure (maximum grade: 9) and only 8 people being unwilling to undergo another scan for any reason. Factors independent of the stronger magnetic field such as the long data acquisition time (7T: 72.3min; 1.5T: 37.1 min), the requirement to lie still or the noise were primarily criticized at 7T. Although volunteers complained significantly more often about vertigo, metallic taste, nausea or fear during the 7T-scan compared to 1.5T ( $p<0.03$ ), all of these sensations were only of minor degree (average grade: <2) (Figure 1). Volunteers positioned “head first” considerably more often described sensations and side effects than people lying “feet first”; however, again non-specific factors such as room temperature, the requirement to lie still and having little contact to the staff were rated worse than vertigo etc. (Figure 2). Neither on 1.5T nor on 7T there was a significant difference between the genders in rating of the examinations.



**Figure 1.** Paired comparison of 166 volunteers, who underwent both 1.5T and 7T examination. The graph shows the average grades given in the post-exam questionnaires regarding causes for discomfort with an asterisk indicating significant differences.



**Figure 2.** Average grades for causes of discomfort as rated by the volunteers lying either “feet-first” or “head-first”. Especially non-specific factors were significantly more often criticized by the “head-first” group as indicated by the asterisks.

**Conclusions:** The 7T examinations were well tolerated and were accompanied by a high degree of subjective acceptance within the study population with only few field-strength-dependent side effects.