Efficacy of Diphenhydramine in the Prevention of Vertigo and Nausea at 7 Tesla

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INTRODUCTION

The major advantage of ultra-high-field magnetic resonance tomography is the significantly higher signal-to-noise ratio. It is conceivable that the development and the use of these scanners, mainly with 7 Tesla, will aim at clinical applications. The number of 7-Tesla scanners is increasing around the world. With the increase in field strength different side effects concerning the sensations of the patients become relevant. At 7 Tesla over 25% of the patients report vertigo symptoms during table motion and 6% report nausea [1]. Small magneto-hydrodynamic forces affecting the endolymph in the membranous labyrinth of the inner ear may be the source of sensations of vertigo and nausea [2]. For a high degree of acceptance it is important to minimize or avoid these physiologic effects if possible. Because of the similar cause of vertigo in motion sickness, the aim of this study was to evaluate whether the antihistaminic drug diphenhydramine can prevent vertigo and nausea caused by motion in the strong static magnetic field gradient. This could potentially improve patient acceptance and comfort in ultra-high-field scanners.

MATERIALS AND METHODS

After approval by the local Ethics Committee and after informed consent, 30 healthy volunteers were included in this prospective double-blinded, placebo controlled, cross-over randomized study [Fig.1]. The experiments were performed on a whole-body 7 Tesla scanner (Siemens Medical Solutions, Erlangen, Germany) without the use of the gradient system or radiofrequency pulse. Subject sensations were reported in a questionnaire before and after moving the subjects into the static magnetic field with and without oral administration of 20mg diphenhydramine respectively saline solution as a placebo dissolved in 200ml water. The table motion speed was 0.2 m per second, which is about ten times faster than the normal speed. The subjects described and rated the appearance of different possible physiologic sensations such as vertigo, nausea, metallic taste, light flashes and the possible side effects of the drug, e.g. drowsiness or dry mouth, on a ten point scale separately for the different examination phases moving-in, resting in the isocenter and moving out. Additionally the subjects were asked for other causes of discomfort like bore narrowness or room temperature. In ten subjects the blood plasma level of diphenhydramine was determined.
Paired Wilcoxon test was used for significance testing.

RESULTS

All 30 subjects finished the examination. 14 male and 16 female volunteers (mean age: 28 years; range 22 – 57 years) were included. For 11 of them it was the first exposure to the magnetic field of an MR-scanner, 4 volunteers had previous experience in the 7 Tesla scanner. 15 subjects reported sensations related to the high static magnetic field (11 vertigo, 1 metallic taste, 4 light flashes). None of them reported nausea during the study. During all three phases, vertigo did not disappear under diphenhydramine administration, but the rating of its strength was decreased relatively to no medication. The maximum strength during moving in decreased from 9 to 5. During rest and moving out a clear but non-significant decrease was detected. A placebo effect could not be shown. Likewise the appearance of the other physiologic sensations did not show a significant correlation to the administration of the antihistamine or the placebo. None of the measured plasma levels of the drug exceeded the drowsiness level of 30ng/ml.

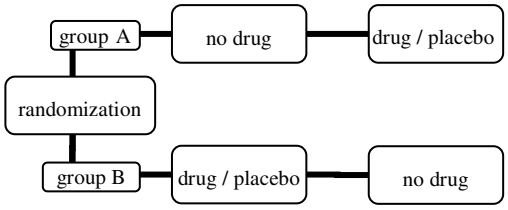

Fig. 1: Scheme of the cross-over randomization.

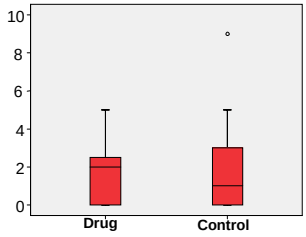

Fig. 2: Strength of vertigo during moving into the scanner

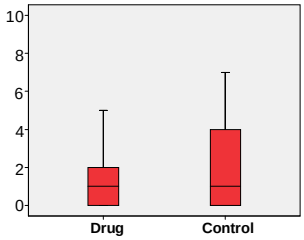

Fig. 3: Strength of vertigo during rest in the isocenter of the scanner

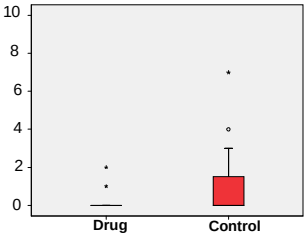

Fig. 4: Strength of vertigo during moving out of the scanner

Habituation effects were disregarded

DISCUSSION

To increase the incidence of vertigo, the table speed was dramatically increased compared to standard settings. Even under these conditions only one third of the subjects reported sensations caused by the magnetic field exposure. Prophylaxis with the antihistamine diphenhydramine reduces the strength of vertigo during examinations in an ultra-high-field MRI scanner. Oral administration of the drug was well tolerated and no side effects were reported. The administration should also be possible in cognitive studies as it does not affect subject concentration. With higher doses the effect on reduction of vertigo may be even stronger. Beside the effect of the drug a habituation effect may also play a role in the decrease of the strength of vertigo, but therefore and for yielding significant facts more subjects are needed. In addition, the time of administration may be optimized as suggested by our results indicating that the positive drug effect was strongest at the end of the examination.

REFERENCES

[1] Theysohn JM et al.: Subjective acceptance of 7 Tesla MRI for human imaging. Magn Reson Mater Phy, 2007
[2] Schenk JF: Safety of Strong, Static Magnetic Fields. JMRI, 2000