Cerebral Activation Pattern before and after Dry Water Immersion

S.M. Golaszewski[1,3], F. Gerstenbrand[3,5], W. Struhal[3,5], E. Gallasch[2], M. Berger[3], S. Lechner-Steinleitner[3], C.M. Siedentopf[4], S.R. Felber[4]

Department of [1]Neurology and [2]Physiology, University of Graz, Austria
Inst. for [3]Space Neurology and [4]Dept. of Radiology II, Univ. of Innsbruck, Austria
[5]Ludwig-Bolzmann-Institute for Restorative Neurology and Neuromodulation, Vienna, Austria

INTRODUCTION The aim of this study was to deprivate the brain from proprioceptive input and thus to evaluate the effects of simulated microgravity or immobilization on cortical activation patterns of the sensorimotor cortex.

MATERIALS AND METHODS All experiments were performed on a 1.5 Tesla MR-scanner with a conventional circular polarized head coil. The on/off motor paradigm was a monitored finger-to-thumb-tapping with the left hand.

The experimental setup consisted of a baseline fMRI examination (test motor task, TMT) before the 48 hours of sensory deprivation with dry water immersion (DWI, fig.1), a conditioned fMRI examination ten minutes after the sensory deprivation (conditioned motor task, CMT) and a third fMRI examination one week after the second one. The experiments were performed with four healthy male volunteers.

Post processing was done with SPM99.

RESULTS The baseline fMRI examinations revealed bilateral activation within the primary motor (MI) and the primary sensory cortex (SI). Activation within the secondary sensory cortex is summarized as SII activation. In addition, the baseline fMRI examination reveals activation bilateral within the supplementary motor area (SMA) and the premotor area (PM). After 48 hours of sensory deprivation, we observed extensive changes of the cortical brain activity. There is a consistent profile of changes between the studied cortical brain areas of the MI, the SI, the PM, the SMA and the SII. Another phenomenon observed was the new activation within the ipsilateral Globus Pallidus (GP) in CMT. SMA showed increased activation of more than 100% after sensory deprivation in all subjects. Secondly, there was an increase of more than 70% of activation within the ipsilateral PM in CMT. Increase of activation was also seen bilaterally within the MI/SI activation focus with emphasis on the ipsilaterale hemisphere. The same was true for the SII, where the contralateral increase of activation was less pronounced. Further, CMT showed new activation within the ipsilateral GP in 3 subjects. Performing another fMRI experiment one week after the CMT, these changes disappeared, and approximately the same activation pattern as in the TMT was observed.

CONCLUSIONS Dry Water Immersion (DWI) modifies the organization of afferent sensory information which is involved in motor regulation.
Following this sensory deprivation, we found a significant increase in activity in higher motor control areas compared to the pretest baseline.
With regard to optimal rehabilitation of patients with focal brain injuries and stroke, our results support proprioceptive stimulation during long-term bed rest and immobilization.

Fifth International Head-Out Water Immersion Symposium

October 8-9, 2002
Center for Advanced Space Studies
Houston, Texas