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Caloric stimulation in patients with bilateral vestibular failure (a PET study)

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Purpose:

In an earlier PET study we showed that caloric irrigation in healthy volunteers elicits bilateral activation of the vestibular cortex (posterior insula and retroinsular regions: the human homologue of the multisensory parieto-insular vestibular cortex PIVC), adjacent middle and superior temporal gyri, the dorsolateral thalamus, anterior and posterior cingulate gyri and ocular motor areas, as well as a highly significant deactivation of the entire striate visual cortex (BA 17,18,19) [1]. The aim of this study was to determine, how vestibular failure affects the activation-deactivation pattern in patients with bilateral vestibular failure (BVF)[2]. Loss of vestibular function was due to autoimmunological disease or ototoxic medication, which damaged the vestibular hair cells.

Methods:

Nine right-handed patients (4 males and 5 females, aged 40 to 75 years) with BVF were examined in a Siemens PET scanner using a O-15 water-bolus technique. Nystagmus after caloric irrigation of the ears and postrotationally was significantly reduced. Three stimulation conditions were presented to the subjects: caloric irrigation of the right (A) or left ear (B) with water at 44°C, and the rest condition (C), which was performed without caloric stimulation and with eyes closed. Prior to single-subject statistical analysis and random effects group analysis data were realigned, spatially normalized, and smoothed using SPM99 (The Wellcome Department of Cognitive Neurology, London, UK). Differences between control and activation images were expressed as statistical parametric maps ($p < 0.001$, uncorrected).

Results:

The group analysis of healthy subjects vs. patients (contrast A vs. C) revealed significantly more activation of the posterior insula, the inferior parietal gyrus (BA40), the anterior cingulate gyrus, the precuneus (BA7) and the middle frontal gyrus (BA46/9) (two-sample t-test) in the healthy subjects. The deactivation pattern (contrast C vs. A) for the patients was changed in that deactivation was not seen in the primary visual cortex but was seen in the precuneus (BA 7). The healthy volunteers showed significantly more deactivation in the primary visual cortex (BA17/18) and the middle temporal gyrus (BA21) than the patients did.

Conclusion:

The activation-deactivation patterns found in healthy volunteers and patients with BVF differ significantly. In the patients:

1. activations of vestibular cortex areas were significantly reduced,
2. no further cortical areas were activated (cingulate gyrus, ocular motor areas), and
3. an inhibitory interaction with the primary visual cortex was absent.

Thus, the inhibitory reciprocal mode of interaction between visual and vestibular systems is not developed due to reduced vestibular input.

References:

1. Wenzel et al., Brain 1996,119, 101-110
2. Baloh and Furman, West J Med 1989, 150, 59-67