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Blok B. [1], Groen J. [2], Bosch J.[3], Veltman D. J [4], Lammertsma A.[4]
1. Dept. Urology, AMC, 2. AZR Dijkzigt, Rotterdam, 3. Urology, AZR Dijkzigt, Rotterdam, 4. PET center, AZVU, Amsterdam

BRAIN ACTIVATION DURING SACRAL NEUROMODULATION IN URGE INCONTINENCE: A COMBINED PET AND MRI STUDY

Aims of Study
The effects neuromodulation in urge incontinent patients on the central nervous system are unknown. Studies in animals have described the basic central components of the micturition reflex. Previous positron emission tomography (PET) studies in healthy men and women have demonstrated similar brain structures involved in micturition and continence. The authors hypothesized 3 possibilities for the origin of the effect of neuromodulation: 1) neuromodulation effects specific micturition and continence related areas; 2) neuromodulation influences non-specific areas involved in mechanisms as arousal or attention; 3) a combination of 1) and 2). The present study was designed to test this hypotheses in patients suffering from urodynamically defined urge incontinence and who have proved to benefit from sacral neuromodulation.

Methods
Neural activation in the brain was measured in 12 urge incontinent patients (mean age 51 years). Sacral neuromodulation had been shown effective in these patients for more than 6 months (mean time after implantion 4.5 years). Patients were placed in the PET camera (ECAT EXACT HR+, Siemens-CTI, USA). During scanning vesical pressure was measured with a 8 Ch transurethrally placed catheter and a surface EMG of the pelvic floor was registered. Urodynamic examination includes a filling cystometry followed by determination of the voided volume. Filling cystometries are performed in supine position in the PET scanner. Each study consisted of 10 scans with 5 times the neurostimulator on and 5 times off in a randomized order. For each emission scan 450 MBq H215O was injected intravenously using an infusion pump. A structural MRI was made of each patient in order to obtain the exact location of the PET activity. The data of each scan were summated and further analyzed using the Statistical Parametric Mapping software (version SPM 99). An omnibus P-value less than 0.001 was considered significant for areas involved in micturition and continence.

Results
During sacral neuromodulation significant increases in bloodflow were seen in the cortical areas (left middle frontal gyrus, left temporal lobe, and the right insula), but none in the brainstem. Significant decreases during neuromodulation were seen in a large area of the mesencephalic reticular formation and adjacent midline thalamus, the middle part of the cingulate gyrus and the most inferior part of the medial frontal gyrus.

Conclusions
Our data suggest that the supraspinal effects of sacral neuromodulation originate from two mechanisms: 1. the micturition-dominant right hemisphere becomes relatively less active; 2. decrease of activity in areas important for general arousal, bladder filling sensation and the onset of micturition. No activation was observed in areas important for the micturition reflex itself. Future PET studies in patients, in which neuromodulation is ineffective should be carried out to assess whether there are differences with the patients treated successfully with neuromodulation.

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