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BRAIN PLASTICITY AND URGE INCONTINENCE: PET STUDIES DURING THE FIRST HOURS OF SACRAL NEUROMODULATION

Aims of Study

Previous positron emission tomography (PET) studies in healthy volunteers have demonstrated brain structures involved in micturition and continence (1).Furthermore, it was shown recently that specific cortical and subcortical areas are activated during sacral neuromodulation in incontinent patients whom benefited long term from the implant (2).The maximal beneficial effect of neuromodulation is not reached immediately, but after several hours or days. This suggests that neuromodulation induces plastic learning changes in the brain. The present study investigated which brain areas are responsible for these initial learning effects.

Methods

Eight urge incontinent patients, who responded successfully (>50% less leakage and pad use) to a test stimulation (PNE) during 4 to 6 days with a temporary, percutaneously placed wire electrode, received a permanent implant; an S3 foramen electrode connected to a subcutaneously placed pulse generator (Medtronic Interstim). Patients were placed in the PET camera (ECAT EXACT HR+, Siemens-CTI, USA). During scanning urethral and vesical pressures were measured with an 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. The pulse generator was switched on for the first time in the scanner. Each study consisted of 10 scans with 5 times the neuromodulator on and 5 times off in a randomized order. For each emission scan 450 MBq H_2O^{15} was injected intravenously using an infusion pump. 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. Covariance in time was investigated by giving less weight to the first scans and more weight to the last scans.

Results

During the initial sacral neuromodulation significant increases in blood flow were seen in the primary motor cortical areas associated with abdominal and pelvic floor musculature, the left lateral cerebellum and the mid cingulate gyrus, but none in the brainstem. Significant decreases during initial sacral neuromodulation were not observed.

Conclusions

Our data suggest that during the first hours of sacral neuromodulation in urge incontinent patients strong plastic changes are induced in specific brain areas, i.e. the lower trunk motor cortex and the cerebellum. These areas are known to be important for learning of motor behavior. After the initial learning period the pelvic floor and abdominal motor cortical areas are more easily excited and the effects of neuromodulation are prolonged and pronounced greatly. Activation in the mid cingulate gyrus may reflect a temporarily increased awareness of the sense of bladder filling. No plastic changes were seen 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 in comparison to patients treated successfully.

Source of Funding
Medtronic Interstim

References

1. (Blok et al., Brain, 1997, 1998; Athwal et al., Brain, 2001).
2. (Blok et al., ICS 2002).