

A PET STUDY TO ASSESS SUPRASPINAL RESPONSE TO SACRAL NEUROMODULATION IN WOMEN WITH URINARY RETENTION

Aims of Study

Sacral neuromodulation has been shown to restore voiding function in women with urinary retention attributed to urethral sphincter overactivity. Although the mechanism of action is not established, there is strong evidence to suggest its effect is on the afferent innervation. Functional brain imaging is a useful tool to localise the cerebral areas involved in central processing of visceral information. Previous studies have demonstrated the role of brainstem regions in relaying afferent information during urine storage and activation of other areas during micturition. Women with this type of retention characteristically have their sensation of bladder filling restored by neuromodulation. We have therefore aimed to investigate the central effects of chronic neuromodulation in these patients by a series of Positron Emission Tomography (PET) scans with stimulation on and off. This was contrasted with scans in healthy female control subjects.

Methods

With the approval of the local Ethics Committee and a current Radionuclide licence, a 2x2 experimental paradigm was used in this PET study. A Siemens ECAT scanner was utilised with the standard oxygen-15 bolus technique. We performed 12 PET scans in healthy female volunteers (aged over 40), 6 scans with the bladder empty and 6 with the bladder full. Before each scan we measured the bladder volume (with a portable ultrasound scanner) and recorded the sensation of fullness (using a validated scoring system).

Women with a permanent sacral nerve stimulator for retention had 6 scans with the stimulator switched on and 6 with it deactivated. During each session, the bladder was empty in 3 scans and full in the other 3 (by natural filling). The order for all scans was counterbalanced.

The images underwent standard normalization, realignment and smoothing before analysis using Statistical Parametric Mapping (SPM99). Covariate analysis was also performed to assess relationship between specific brain activity and sensation of bladder fullness.

Results

We recruited 8 healthy female volunteers (aged 40-62) and 6 women with urinary retention successfully treated by neuromodulation (aged 39-52). In the control subject group analysis, areas activated when the bladder was full (compared to being empty) were the cingulate cortex, midbrain and pons. In the group analysis for the patients, the pontine activation associated with a full bladder was only seen when the stimulator was switched on. The study design ensured there was no possibility of any carry-over effects of stimulation. Reviewing the effects of interest across the scans revealed that activation of neuromodulation improved the subjects' ability to discriminate a full versus empty bladder. There was significant correlation between bladder sensation (urge score) and pontine activation (Pearson's coefficient 0.284) for all subjects.

Conclusions

Restoration of voiding by neuromodulation seems to involve central mechanisms, involving the brainstem and cingulate cortex. Although this does not establish whether sacral nerve stimulation has its primary effect at a spinal or supraspinal level, nevertheless these results confirm that there are cerebral effects of neuromodulation in urinary retention. The clinical finding that neuromodulation restores the sensation of bladder filling in these women is supported by evidence of improved discrimination of the bladder being full versus empty when the stimulator is activated. Study of the psychophysiological interactions may help us further elucidate the functional relevance of the areas activated in the different conditions.