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MODULATION OF DESIRE-TO-VOID WITH PELVIC FLOOR CONTRACTION: AN FMRI STUDY

Hypothesis / aims of study

Functional brain imaging using positron emission tomography (PET) has demonstrated that *states* of bladder fullness and desire-to-void are associated with enhanced neural activity in cerebral cortex (anterior cingulate and prefrontal cortices) and brainstem (periaquaeductal grey (PAG) and pons) (1). Previous work has shown that pelvic floor contraction can modulate the perception of desire-to-void.

Brain imaging with functional magnetic resonance (fMRI) enables *dynamic* assessment of second-by-second changes in brain activity, achieved with greater spatial resolution and without invasive administration of radionucleotides.

To clarify central mechanisms representing bladder fullness and control of voiding, we used fMRI to 1) identify where brain activity dynamically reflects changes in bladder filling and the desire-to-void and 2) examine neural mechanisms by which contraction of the pelvic floor modulates the desire-to-void. Here, our report focuses on the brain structures supporting the subjective desire-to-void.

Study design, materials and methods

We scanned nine healthy women (aged 21-34) with no urinary symptoms or urological, gynecological, neurological or psychiatric disorder in a 1.5T Siemens Sonata scanner using standard fMRI methodology with local ethics committee approval. The women were scanned in counter-balanced 'full' and 'empty' bladder sessions. Whole brain images of changes in regional activity were obtained every 4.32 seconds with 219 scans obtained in each session. During scanning, subjects repeatedly rated their desire-to-void on a 5 point validated scale and performed pelvic floor contractions for 6s or 12s paced externally via a video monitor with alternating periods of rest.

Using SPM2 we conducted voxel-wide multiple regression analysis of our individual and group fMRI data to discriminate between the experience of bladder filling and effects of pelvic floor contraction.

Results

A group analysis of all 9 showed that activity within dorsal prefrontal and anterior cingulate cortices, PAG and cerebellum was positively correlated with subjective increase in desire-to-void during bladder filling, whereas activity within inferior prefrontal cortex, insula and pons was negatively correlated.

Pelvic floor contraction resulted in a decrease in desire-to-void level in 7 of the 9 women. A group analysis of these 7 subjects showed, similar regions to the above with activation of prefrontal regions, but attenuation of activity in the pons, anterior cingulate and insula.

Interpretation of results

These results provide further insight into brain mechanisms in the central control of micturition already implicated by PET imaging. Desire-to-void engenders the recruitment of higher-order brain regions such as dorsal prefrontal and cingulate cortices thought to be involved in cognitive control of action and also, in the case of anterior cingulate cortex in control of visceral and motivational responses. Moreover, attenuation of activity within insula and pons is likely to represent top-down inhibition of a cortical representation of bladder filling and a brainstem micturition reflex for the maintenance of continence.

A change in activity of similar regions with decreases in desire-to-void with pelvic floor contractions provides further evidence that these regions are important in the perception/modulation of bladder sensation.

Concluding message

fMRI is providing further information on the central control of micturition in humans. Future research should focus on investigating the hierarchical organization of these regions in the central control of micturition. Functional imaging is providing the answer to "What brain areas are involved in the central control of micturition?" The next question to be answered "How is this achieved?"

1. 2001. Brain responses to changes in bladder volume and urge to void in healthy men. Brain 124(Pt 2):369-377.

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