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SUPRASPINAL LOWER URINARY TRACT CONTROL IN SPINAL CORD INJURY PATIENTS: A STRUCTURAL AND FUNCTIONAL MRI STUDY

Hypothesis / aims of study
The control of the lower urinary tract (LUT) is a complex, multilevel process involving both the peripheral and central nervous system. Most patients with a spinal cord injury (SCI) suffer from neurogenic LUT dysfunction. Although there are several concepts regarding neuronal control and perception in the normal and pathological LUT condition, the exact mechanisms involved remain to be elucidated.

Study design, materials and methods
In this magnetic resonance imaging (MRI) study, we prospectively assessed healthy controls (n=26, mean age 41±12 yrs.) and SCI patients (n=26, mean age 37±11 yrs.) with neurogenic detrusor overactivity. The SCI cohort comprised patients with complete (n=15) and incomplete (n=11) lesions. All subjects underwent structural and functional MRI (fMRI) measurements using a 3T scanner. The fMRI paradigm contained automated, repetitive bladder filling of 100mL body warm or cold (4 centigrade) saline starting with an empty or pre-filled bladder, i.e. block design, by using a magnetic resonance compatible and synchronised infusion-drainage system. Blood-oxygenation-level dependent (BOLD) signal change during bladder filling was compared to rest, i.e. empty/pre-filled bladder. Second-level random effects analysis included one-sample t-tests for each group and two sample t-test for intergroup comparison.

Results
One SCI patient had to be excluded due to head motions during data acquisition. FMRI revealed significant ($p \leq 0.05$, familywise error-corrected) supraspinal activation during LUT stimulation in both controls and SCI patients in areas known to be involved in LUT control, i.e. bilateral prefrontal cortex (PFC) and orbitofrontal cortex, cingulate cortex, bilateral insula, basal ganglia and secondary motor cortex. SCI patients showed significantly more activation than controls. In addition, activation in primary and secondary somato-sensory areas was seen in patients. In the periaqueductal grey, BOLD signal increases could only be demonstrated in controls during bladder stimulation with body warm saline. No significant difference was seen between patients with complete and incomplete SCI, no correlation between lesion level and BOLD signal could be found.
Structural analysis showed a significant volume decrease in the PFC and the right frontal operculum in patients vs. controls overlaying specific regions of interest containing supraspinal areas involved in LUT control.

Interpretation of results
Brain activations in areas known to be involved in LUT control were found in in controls and SCI patients. Overall, patients showed more activation than controls. an effect that might be explained by compensatory mechanisms. The missing activation in the periaqueductal grey and increased activation in secondary somato-sensory areas in SCI patients could support the hypothesis that extra-spinal pathways might be involved in LUT control and overtake sensory functions.

Concluding message
Controls and SCI patients showed task-related supraspinal activation during LUT stimulation in areas known to be involved in LUT control.

Disclosures
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