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Brain activation in response to urinary bladder uninhibited detrusor contraction in spinal cord injured patients measured by fMRI

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Aim:

In the past decade, considerable research attention has been paid to the central neural control of the lower urinary tract. However, our understanding of the neuroregulation of the urinary bladder is still incomplete. Bladder afferents follow mainly anterolateral and posterior white columns of the spinal cord. Little is known about the extraspinal afferent pathways in human.

The aim of the study is to evaluate the extraspinal sensory pathways in spinal cord injuried patients using functional magnetic resonance.

Material and Methods:

Patients: A total of 13 right-handed men and 1 woman (age 24–54 years) were enrolled. All patients experienced complete spinal cord injury (ASIA A) at level C7-Th5 on average 15 months before entering the study.

A double-lumen, soft 8-Fr bladder catheter was inserted into the bladder. Standard urodynamic equipment was used for repeated bladder filling and measurements of intravesical pressure. The bladder was filled at an infusion rate of 25 ml/min up to 50 and 100 ml. After the initial bladder filling, rapid filling and emptying of the bladder with 25 mL of the infusion solution was initiated in order to strengthen the sensory stimulus. Then the bladder was filled until uninhibited detrusor contraction has been occurred.

After emptying the bladder the assessment was repeated 3-times in every subject. Complete design can be seen in fig.1.

All fMRI measurements were performed on Siemens Trio 3T scanner using GRE- EPI sequence (FOV=192x192mm, voxel 3x3x3mm, TR/TE=3000/30ms, 45 slices). Total of 900 dynamical scans was acquired and measurement lasted 45 min.

Statistical analysis was done in SPM8 using GLM. All blocks with the episode of uninhibited detrusor contraction was defined as one condition. Realign parameters (shifts and rotations) were used as additional regressors. Final statistics using t-test was calculated (p=0.001 uncorrected or with FWE correction).

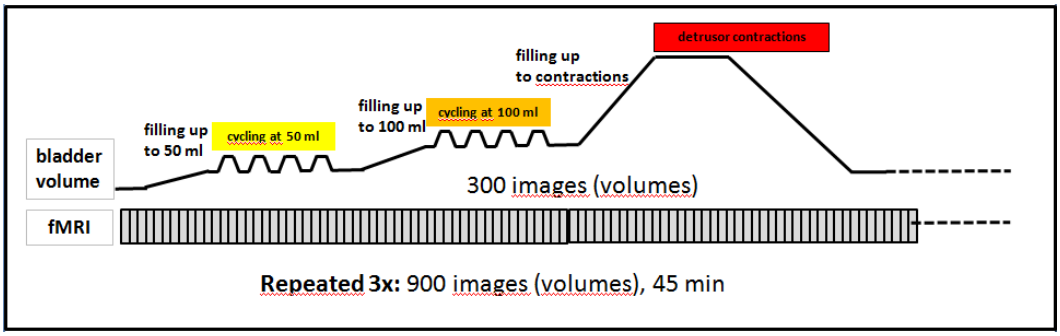

Fig.1. Stimulation scheme

Results:

In 3 cases we could not achieve the situation of uninhibited detrusor contraction. In 9 of our 14 patients we were able to get any brain response corresponding to an unhibited detrusor contraction. In remaining 2 cases either high level of motion artifacts caused by muscle spasms or unpredictable bladder reaction did not allow to recognize any activation. Six of our patients activated at least one area in parabrachial region, amygdala, thalamus, anterior cingulate, prefrontal cortex (fig. 2a). However, three patients showed extensive activation in wide range of brain regions in reaction on the uninhibited detrusor contraction (fig. 2b).

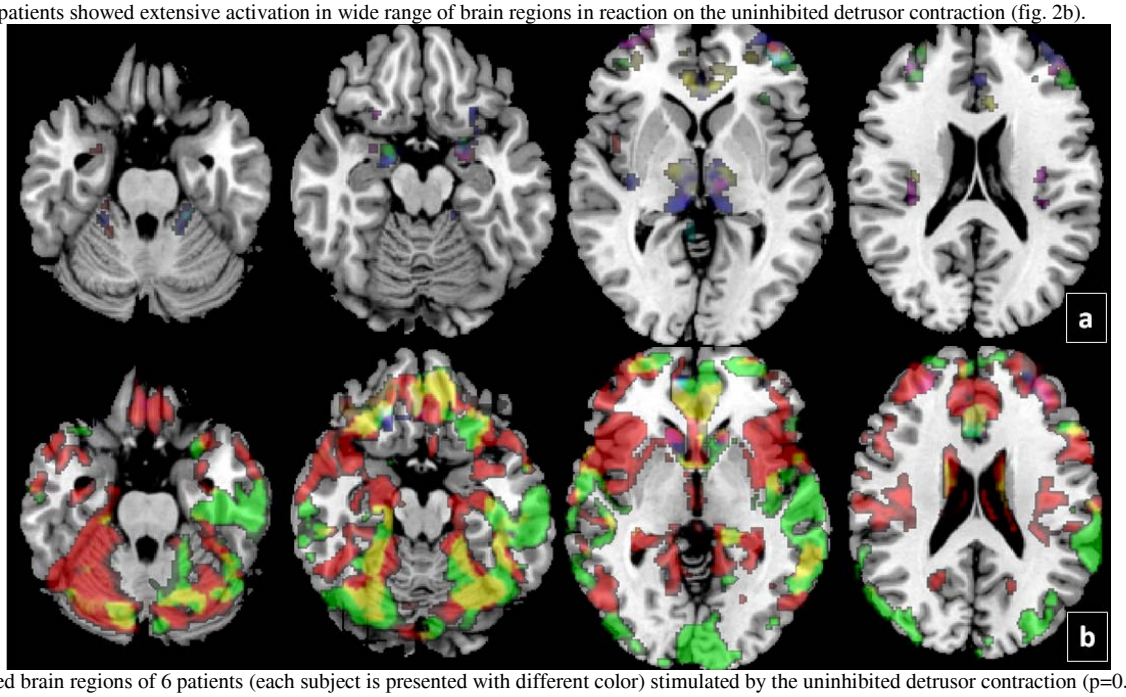

Fig.2. a) activated brain regions of 6 patients (each subject is presented with different color) stimulated by the uninhibited detrusor contraction (p=0.001 uncorrected), b) three other subjects with very extensive activation in over many brain regions in reaction on the uninhibited detrusor contraction (p=0.001 with FWE correction, again separated with different colors).

Conclusions:

Our data provide evidence that both spinal and extraspinal sensory pathways are involved in the neural control of the lower urinary tract.

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