

## BRAIN ACTIVITY ASSOCIATED WITH URINARY BLADDER FILLING IN PATIENTS WITH A COMPLETE SPINAL CORD INJURY (SCI) – A FMRI STUDY

### Hypothesis / aims of study

It is commonly known that patients with complete spinal cord injury (SCI) may maintain some perception of bladder fullness and, therefore, exert to some extent neural control of their lower urinary tract [1].

In the intact spinal cord, afferent sensory signals from the lower urinary tract ascending the anterolateral and posterior white columns of the spinal cord. These spinal pathways are lesioned in SCI patients and there is limited information about extraspinal sensory afferents in humans.

The aim of this study was to evaluate brain activation due to anticipated extraspinal sensory pathways. Using functional magnetic resonance (fMRI) we evaluated brain activity associated with urinary bladder filling in patients with a complete SCI. We hypothesized that bladder filling until maximal capacity results in activation of brainstem and forebrain areas receiving information from the vagal nerves.

### Study design, materials and methods

A total of 14 patients (13 male, 1 female) age 24–54 years were enrolled in the study.

All patients experienced, 15 months before entering the study on average, complete SCI (ASIA A) at level C7 to Th 5.

Urodynamic equipment was used for repeated bladder filling and evaluation of detrusor activity. The bladder was filled with 37C saline 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 increase the strength of a sensory stimulus. Then the bladder was filled up until an uninhibited detrusor contraction occurred. In the end we emptied the bladder. This protocol was repeated 3 times in every subject. 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 were acquired and the duration of complete assessment was 45 min.

Statistical analysis was done in SPM8 using general linear model. Single subject as well as final group statistics using t-test were thresholded at p=0.001.

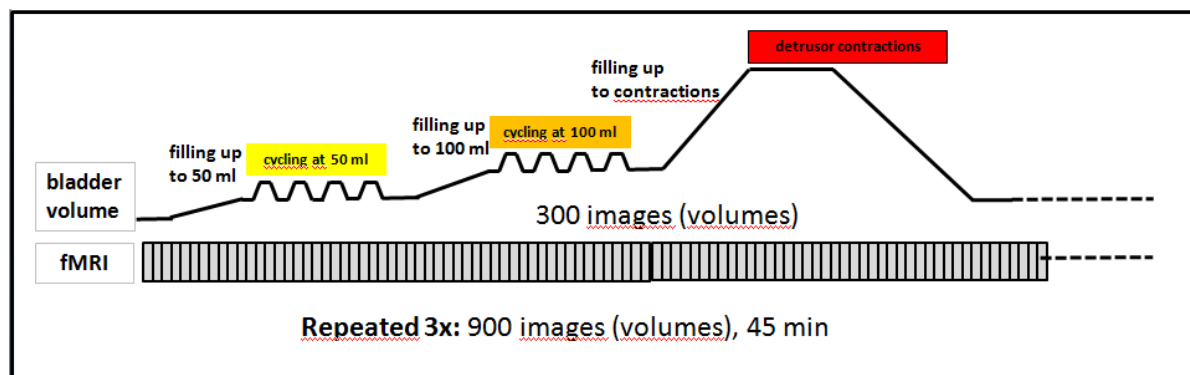


Fig.1. Stimulation scheme

### Results

We excluded results from 2 patients due to activation artifacts related to very strong vegetative response (autonomic dysreflexia). In 8 of 12 patients significant brain activity was observed during urinary bladder filling.

We found significant activation clusters at nucleus of the solitary tract (NTS) (3/8), parabrachial nucleus (4/8), hypothalamus (4/8), thalamus (6/8), amygdala (7/8), insular lobe (5/8), anterior cingulate gyrus (50%) and prefrontal cortex (8/8) as presented in Tab.1

Subject	Level of spinal lesion	Brain regions activated								Vegetative response
		Nucleus of the solitary tract	Parabrachial nucleus	Hypothalamus	Thalamus	Amygdala	Insular lobe	Anterior cingulate gyrus	Prefrontal cortex	
1	C 6	+	+	+	+	-	-	+	+	-

2	Th 5	-	+	+	+	+	+	+	+	-
3	Th 3	-	-	-	-	-	-	-	-	+
4	Th 4	-	-	-	-	-	-	-	-	-
5	Th5	-	-	-	+	+	+	-	+	-
6	Th 5	+	+	+	+	+	+	+	+	-
7	Th 5	+	+	+	-	+	-	-	+	-
8	Th 5	-	-	-	-	+	-	-	+	-
9	Th 4	-	-	-	-	-	-	-	-	-
10	Th 5	-	-	-	-	-	-	-	-	+
11	C 5	-	-	-	-	-	-	-	-	-
12	Th 4	-	-	-	-	-	-	-	-	-
13	Th 3	-	-	-	+	+	+	+	+	-
14	C6	-	-	-	+	+	+	+	+	-

Tab.1 Brain activity associated with urinary bladder filling in patients with a complete spinal cord injury.

Interpretation of results

There is a significant activation at vagal nerve nuclei during bladder filling.

Concluding message

This study provides evidence that extraspinal sensory pathways are involved in the neural control of the lower urinary tract in complete SCI patients. The activity clusters in the brain might be associated with vagal nerve afferents.

References

1. de Groat WC, Yoshimura N: Changes in afferent activity after spinal cord injury. *Neurourol Urodyn* 2010; 29(1): 63-76

Disclosures

**Funding:** The study was supported by a grant NT/14183 from the Ministry of Health, Czech Republic **Clinical Trial:** No **Subjects:** HUMAN **Ethics Committee:** Study protocol was approved by the Ethics Committee of University Hospital, Ostrava. **Helsinki:** Yes **Informed Consent:** Yes