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A NOVEL INFUSION-DRAINAGE DEVICE TO ASSESS LOWER URINARY TRACT FUNCTION IN NEURO-IMAGING

Hypothesis / aims of study
Recent functional MRI (fMRI) studies revealed supraspinal networks involved in perception and processing of bladder distension in response to bladder filling. However, significance of supraspinal network activity and network localisations varied between studies. This might be related to the different bladder stimulation protocols used and their different level of stimulation task precision. We therefore developed a new automated, multi-configurable, magnetic resonance (MR)-compatible and synchronised infusion-drainage device (IDD) to improve precision of bladder filling tasks during fMRI and to provide a potential base for standardisation of bladder filling protocols.

Study design, materials and methods
The IDD is based on electrohydrostatic actuation. The design includes a master and a slave pneumatic cylinder linked over an extension hose and a multi-configurable motorised slider to provide force and motion.
To evaluate performance quality volume delivery accuracy (i.e. estimated volume (flowrate * infusion time) vs. measured volume) was tested preforming 8 repetitions of infusion and withdrawal at different flowrates (80 to 400mL/min) and for different infusion times (3 to 60sec), using a flowmeter. MR-compatibility was evaluated using a proton sphere phantom.
Pilot feasibility tests in healthy subjects and patients with lower urinary tract (LUT) symptoms undergoing fMRI during bladder stimulation were performed. In all subjects the bladder was prefilled through an indwelling transurethral catheter up to a certain volume inducing a persistent desire to void reported from each individual subject. The scan paradigm comprised automated, repetitive bladder filling and withdrawal of 100mL body warm saline.

Results
Technical aspects: Mean volume delivery accuracy for different flowrates and filling volumes was between 99.1±1.2% and 99.9±0.2%. MR-compatibility was demonstrated with a small decrease in signal-to-noise ratio (SNR), i.e. 1.13% for anatomical and 0.54% for functional scans and a decrease of 1.76% for time-variant SNR.
Device testing in healthy volunteers and patients: Automated, repetitive bladder filling and drainage was well tolerated by healthy subjects and patients. The paradigm elicited robust (p=0.05, FWE-corrected) brain activity in areas previously reported to be involved in supraspinal LUT control. A strong temporal correlation between LUT stimulation and blood oxygenation level dependent (BOLD) signal changes in such areas was detected.

Interpretation of results
This study introduces a new MR-compatible and synchronised IDD, designed to stimulate the LUT during fMRI. High system accuracy was achieved. BOLD signal changes were in line with results from existing literature.

Concluding message
Using this automated IDD and according standardised study protocols helps to improve precision, repeatability and comparability between studies.

Disclosures
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