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NORMAL MICTURITION AND DETRUSOR OVERACTIVITY RELATED REAI TIME CHANGE OF ACTIVATION IN PREFRONTAL CORTEX: A FUNCTIONAL NEAR-INFRARED SPECTROSCOPY (FNIRS) STUDY

Hypothesis / aims of study

The prefrontal cortex (PFC) is the anterior part of the frontal lobes of the brain, which has been mainly implicated in executive function such as decision making, planning behaviours and controlling social behaviour (the ability to suppress urges that, if not suppressed, could lead to unacceptable outcomes). The importance of the prefrontal cortex in bladder control was also established from clinical and basic studies. Recently functional neuroimaging studies using PET, fMRI and SPECT have shown activation of prefrontal area during withholding of urine or a full bladder and a part of these findings was reported to be abnormally weak in patients with urge incontinence, and it was hypothesized that this is the region which is ''involved in making the decision whether or not micturition should take place''. Last year, we preliminary showed that continuous increase of oxyhemoglobin concentration (oxy-Hb) in patients with normal bladder filling and slight increase of oxy-Hb in patients with DO. However, it is not clear what occurs real timely in the prefrontal cortex under normal micturition and abnormal bladder filling with detrusor overactivity (DO). Therefore, we noninvasively evaluated the real time change of oxy-Hb in prefrontal cortex under normal micturition and DO occurring by using functional near-infrared spectroscopy (fNIRS) and examined the hypothesis mentioned above.

Study design, materials and methods

We recruited 16 subjects with informed consent, who were different from the subjects in preliminary study last year. Eight subjects had no urgency and normal detrusor function during bladder filling (Control group); two women and six men; mean age 56 years (47-83), and 8 subjects had involuntary detrusor contraction (DO) during bladder filling (DO group); 2 with phasic DO and 6 with terminal DO; all men; mean age 68 years (33-85).

The fNIRS probe was placed on two area (right and left) of the subject's frontal head, and we measured oxy-Hb in bilateral anterior parts of prefrontal cortex (may be Brodmann's area 10) during bladder filling (in cystometry) and voiding (in pressure flow study) by fNIRS (NIRO 200, Hamamatsu Photonics Inc, Japan).

Results

In the control group, oxy-Hb in bilateral anterior parts of prefrontal cortex gradually increased from the start to end of bladder filling. And the increase in oxy-Hb turned to baseline just after voiding. In the DO group, the oxy-Hb totally increased, but final increasing rate was significantly smaller than that in control group. Furthermore, the oxy-Hb spontaneously increased at beginning of DO, and in another moment, the oxy-Hb suddenly and remarkably decreased under DO occurring, and the oxy-Hb re-increased at end of DO. In the case with phasic DO, these changes of oxy-Hb were repeatedly shown under each DO appearance and the baseline of oxy-Hb was decreasing gradually at the end of each DO.

Interpretation of results

fNIRS showed that, compared with the change of oxy-Hb in bilateral prefrontal cortex during normal bladder filling, total increasing rate of the oxy-Hb was small and spontaneous biphasic change (increasing to decreasing) occurred every DO. These findings suggest that the abnormal prefrontal cortex activity in patients with DO may be a cause of DO and that the prefrontal cortex activity in those patients may not increase enough to inhibit DO and may pause abnormally or switch to the similar pattern during voiding transiently. fNIRS also showed that the oxy-Hb in bilateral prefrontal cortex increased during normal bladder filing and the oxy-Hb in bilateral prefrontal cortex acutely decreased during voiding. These findings suggest that prefrontal cortex may work to keep storage reflex or inhibit voiding reflex voluntary and in-voluntary and to initiate voiding reflex voluntary. Prefrontal cortex is generally implicated in executive function. And it is hypothesized that prefrontal cortex may be involved in making the decision whether or not micturition should take place. Our results may support this hypothesis.

Concluding message

We showed for the first time some the specific findings of oxy-Hb synchronised with normal micturition and DO occurring in bilateral anterior parts of prefrontal cortex by using fNIRS. fNIRS may be useful to real timely evaluate to higher function of central nervous system and pathophysiology associated with normal and abnormal bladder function.

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