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REAL-TIME MEASUREMENT OF OXYHEMOGLOBIN CONCENTRATION CHANGES IN THE FRONTAL MICTURITION AREA: AN FNIRS STUDY

Hypothesis / aims of study

The frontal cortex has been regarded the higher center for micturition. This is because lesions in the frontal cortex, e.g., the prefrontal cortex, the medial superior/middle frontal gyri, the anterior cingulate cortex and the supplementary motor area, produce marked lower urinary tract dysfunction in humans. Functional neuroimaging in normal volunteers, using SPECT, PET and fMRI, is able to show brain activation in response to bladder fullness and urination; and the activated areas strikingly overlap the lesions described in clinical studies. However, question arises what occurs in the brain in between the onset and offset of bladder filling, or the onset and offset of urination. In order to answer this question, we aimed to real-time measure cortical activity in the frontal micturition area using functional near-infrared spectroscopy (fNIRS), in response to a quasi-natural, continuous bladder filling and urination in a sitting position.

Study design, materials and methods

We recruited 9 subjects with informed consent. Control group comprised 5 subjects; one man and four women; mean age 61 years [38-70], with normal detrusor, and detrusor overactivity group comprised 4 subjects; all men; mean age 55 years [33-65], one of them also had a low compliance detrusor. The probe array for fNIRS is equipped with 16 light emitting and 17 detector probes, 52 channels can be measured simultaneously. Concentration changes in [oxy-Hb] were calculated based on a modified Beer-Lambert approach. The probe array covers the area 8, 10, 44, 46, and more anterior parts of the frontal cortex.

Results

In the control group, 1) slight increase of [oxy-Hb] before first sensation occurred, 2) continuous increase of [oxy-Hb] during bladder filling to the point just after start voiding, 3) continuous decrease of [oxy-Hb] after voiding, 4) in subjects who were unable to urinate, [oxy-Hb] also decreased after attempting to void, 5) the area activated are bilateral lateral prefrontal area, particularly Brodmann's area 8, 10 and 46. In the detrusor overactivity group, 6) increase of [oxy-Hb] before first sensation was rare and frontal cortical activation was weak. Otherwise the results were almost the similar with those in the control group **(Fig 1, Table 1)**.

Interpretation of results

fNIRS has some technical issues to be explored, e.g., it is not possible for NIRS to measure deep brain structures such as the basal ganglia and the thalamus; spatial resolution of fNIRS is not superior to PET and SPECT; and, quantification of fNIRS data is not completely comparable between subjects [1] [2]. Nevertheless, the 'mismatch' between bladder filling volume and bladder sensation was observed during continuous bladder filling by fNIRS, e.g., brain activation started before the subjects had the first sensation. The results may indicate that activation in the prefrontal cortex is related with the bladder volume more than subjective bladder sensation. Another 'mismatch' was observed by fNIRS that brain activation subsided in subjects with unsuccessful urination, where interaction between efferent copy [3] (even urination was unsuccessful) and afferent inputs seemed not negligible.

Concluding message

We performed real-time measurement of [oxy-Hb] changes in the frontal micturition area using fNIRS in response to quasi-natural, continuous bladder filling and voiding in a sitting position. The present study calls for a larger study to ascertain relationship between brain and micturition in a natural environment.

patient	age	sex	diagnosis	storage phase by urodynamics				evacuation phase by urodynamics				oxyhemoglobin concentration increase by fNIRS							
				first sensation FS (ml)	bladder capacity BC (ml)	detrusor over-activity	low compli-ance	detrusor contrac-tility	outlet obst-ruction	marked straining	post-void residual (free flow) (ml)	storage start	storage before FS	storage FS	storage BC	evacuation voiding	evacuation after voiding	main location	device
1	38	F	control	25	350	-	-	no flow		+	90	-	+-	+-	++	++	+-	prefrontal area: Brodmann area 8,10,46	H
2	63	F	control	30	265	-	-	no flow		-	0	-	-	+-	++	++	+-	prefrontal area: Brodmann area 10,46	H
3	67	F	control	254	467	-	-	no flow		-	30	-	+-	+	++	+++	+-	prefrontal area: Brodmann area 10,46	S
4	68	F	control	231	484	-	-	normal	1	-	0	-	+-	+	++	+++	+-	prefrontal area: Brodmann area 10,46	S
5	70	M	control	112	214	-	-	normal	4	-	20	-	+-	+	++	+++	+-	prefrontal area: Brodmann area 10,46	S
average	61																		
6	33	M	spina bifida	143	184	+	+	weak	4	+	100	-	-	+-	+	motion artifact		prefrontal area: Brodmann area 8,10,46	S
7	60	M	cervical and lumbar spondylosis	158	340	+	-	no flow		-	310	-	+-	+-	+	++	+-	prefrontal area: Brodmann area 8,10,46	H
8	62	M	MSA-P	80	253	+	-	weak	0	-	40	-	-	+-	+	++	+-	prefrontal area: Brodmann area 10,46	H
9	65	M	Wernicke's encephalo-pathy	170	436	+	-	normal	2	-	0	-	-	+-	+	++	+	prefrontal area: Brodmann area 10,46	S
average	55																		

Table 1 Results of urodynamic and fNIRS recordings.

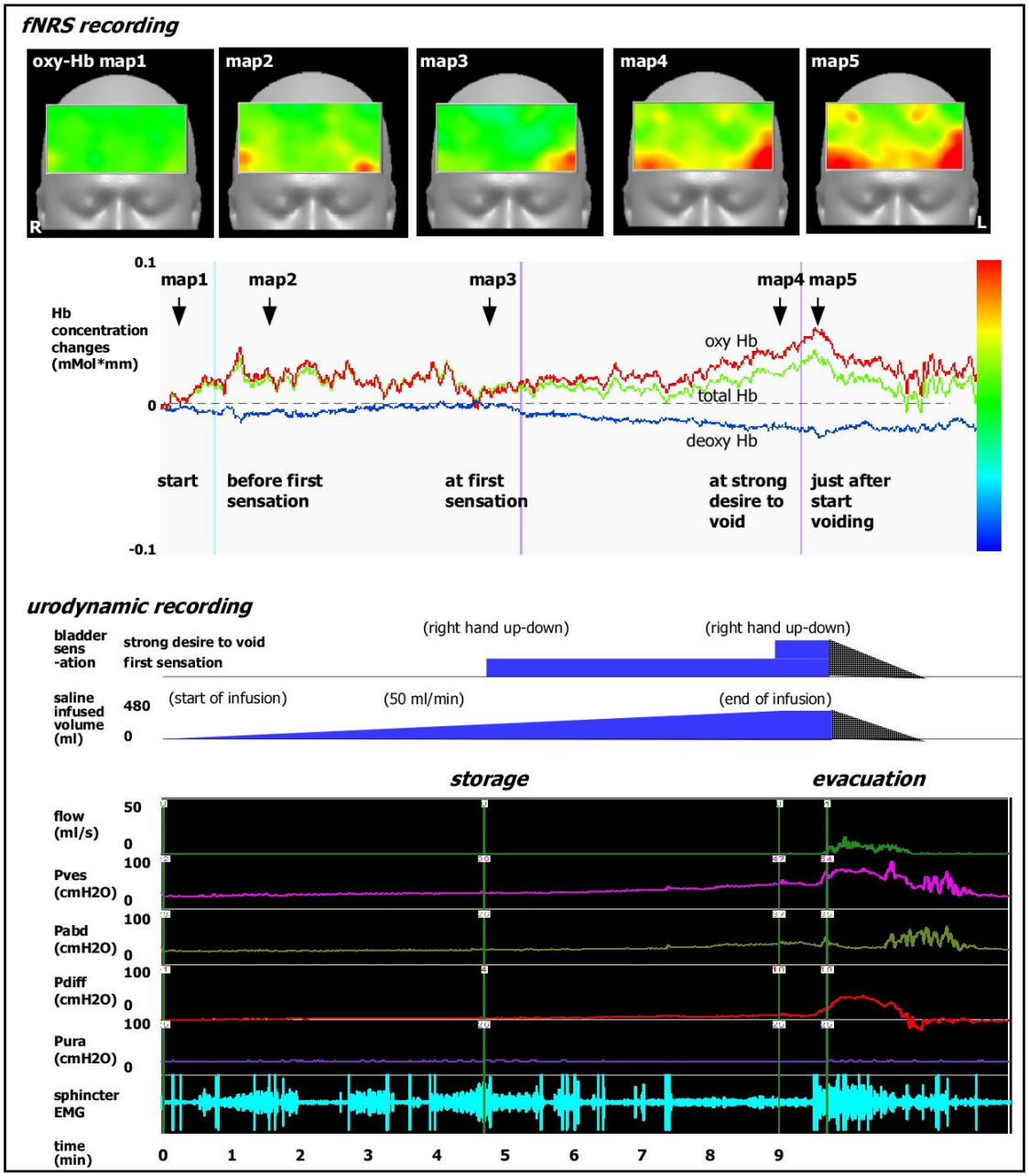

Figure 1 Urodynamic and fNIRS recordings (normal detrusor, urination successful, case 4).

References

1. Biol Psychiatry 2002; 52: 679-693
2. Int Rev Neurobiol 2005; 66: 237-266
3. Neuroimage. 1997; 6: 201-208

Specify source of funding or grant	**No funding or grant.**
Is this a clinical trial?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**Yes**
Specify Name of Ethics Committee	**Ethics Committee in Sakura Medical Center, Toho University**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**