

Development of Screening test of cognitive function in elderly people using time-resolved near-infrared spectroscopy

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Background: Neuroimaging techniques such as fMRI and PET are powerful tools for diagnosis of dementia in the elderly. However, they are complex and expensive, so a simple, non-invasive method for screening cognitive function is required. In the present study, we examined the usefulness of time-resolved near-infrared spectroscopy (TNIRS) for this purpose. Unlike continuous-wave NIRS, TNIRS enables us to measure baseline concentration of Hb in the resting condition by applying a photon diffusion equation. A functional study by TNIRS demonstrated that baseline concentrations of hemoglobin (Hb) in the prefrontal cortex (PFC) reflect regional cerebral blood flow and neuronal activity at rest [1-3].

Subjects and Methods: We studied 78 subjects (male 41, female 37, age 71.5 ± 10.7). Employing TNIRS, we measured baseline concentrations of oxy-, deoxy-, total-Hb ($\mu\text{M/L}$), and oxygen saturation (SO_2) (%). We evaluated cognitive functions by mini mental state examination (MMSE) and Touch M, which evaluates working memory function semi-automatically on a touchscreen.

Results: The mean MMSE and Touch M scores of all subjects were 25.3 ± 4.0 (max 30) and 41.3 ± 22.1 (max 100), respectively. TNIRS revealed moderate but significant positive correlations between Touch M scores and baseline concentrations of oxy-Hb ($r=0.26$, $p<0.02$), total-Hb ($r=0.23$, $p<0.05$), and SO_2 ($r=0.23$, $p<0.05$) (Fig. 1). MMSE showed a significant positive correlation with SO_2 ($r=0.24$, $p<0.02$), but not other parameters.

Discussion: The results suggest that TNIRS may be a useful tool as a screening test of cognitive function, particularly working memory function, in the elderly. It should be emphasized that the present method is suitable for elderly subjects with cognitive dysfunction, who cannot response to cognitive tasks.

References

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