Abstract of Doctoral Thesis

Title: A novel method for evaluating human brown adipose tissue using near-infrared time-resolved spectroscopy

Doctral Program in Sport and Health Science
Graduate School of Sport and Health Science
Ritsumeikan University

にれんぎ しんすけ
Nirengi Shinsuke

Objective: Human brown adipose tissue (BAT) functions as controlling body temperature by cold-induced thermogenesis. To date, \textsuperscript{18}F-fluorodeoxyglucose (FDG)–positron emission tomography (PET)/computed tomography (CT) is the only known method for evaluating BAT activity in humans. However, FDG-PET/CT has serious limitations, such as radiation exposure and acute cold exposure. This study evaluated BAT concentration using near-infrared time-resolved spectroscopy (NIR\textsubscript{TRS}), a simple and noninvasive method for measuring the indices of tissue hemoglobin concentration [total-Hb]. The effect of catechin-rich beverage on BAT concentration was also evaluated.

Methods: We evaluated the [total-Hb] in the supraclavicular region potentially containing BAT. First, the [total-Hb] was compared at 27°C and after a 2-h cold exposure (19°C). Then, [total-Hb] at 27°C were compared with mean standardized uptake values (SUV\textsubscript{mean}) assessed by FDG-PET/CT after the 2-h cold exposure. At last, we compared relationship between cold induced thermogenesis (CIT) and [total-Hb], and we examined seasonal variation in [total-Hb]. Twenty-two healthy women were given either catechin-rich (540mg/d; CAT) or placebo beverage every day for 12 weeks in a randomized, double-blind design. BAT concentration was measured NIR\textsubscript{TRS} and extramyocellular lipids (EMCL) using proton magnetic resonance spectroscopy.

Results and Discussion: There was no significant difference between the [total-Hb] at 27°C and 19°C. The [total-Hb] was significantly correlated to SUV\textsubscript{mean} ($r = 0.73$). A receiver operating characteristic analysis revealed that [total-Hb] was good to determine its reliability. There was a significantly
relationship between CIT and [total-Hb] (r =0.65 p < 0.05). [total-Hb] was significantly higher in winter compared with summer (p < 0.05).

The [total-Hb] significantly increased (18.8% on average) and EMCL was decreased (17.4% on average) after the CT ingestion. There was a significant negative correlation between the changes in BAT mass and EMCL (r = -0.66, p < 0.05).

**Conclusion:** Our novel NIR$_{TRS}$ method is noninvasive, simple and can reliably assess human BAT concentration. The BAT concentration increased by daily ingestion of CAT and increases in BAT concentration correlated with decreases in EMCL.