

Muscle oxygen metabolism measurement for early diagnosis of frailty and diabetes

Our world is rapidly aging and the early detection of physical decline and lifestyle diseases are getting more important for extending healthy life expectancy. The reduced mass and/or function of the skeletal muscle causes frailty that further induces physical and cognitive decline. Frailty is also an important indicator of peripheral artery impairment from lifestyle diseases such as diabetes, hypertension, and hyperlipidemia. For elderly people, recovering muscle mass and function through physical training is difficult after the diagnosis of frailty. We aim to early detect the potential frailty before the muscle mass and function are severely impaired to encourage the people at high risk to change their lifestyle or receive treatment before the symptom development. To predict the risk of muscle loss, we focused on the muscle blood flow response during exercise. We hypothesized that the age-related decline in the ability to regulate the blood flow and utilize the oxygen in the muscle cells may be more obvious during physical exercise than during resting state. Therefore, we developed the near-infrared diffuse optical system (combined DCS-NIRS¹), a novel diffuse optical measurement that can non-invasively evaluate muscle blood flow and metabolism even under light exercise. We have just finished the hardware development and now start a cross-sectional study in which muscle metabolic responses during upper and lower limb exercise in approximately 200 community-dwelling people in their 20-70s. The data will be collected by March 2023. We expect that a detailed analysis of the dataset could determine the standards for evaluating muscle health in the Japanese population, which could be further utilized to early diagnose or predict the risk of frailty and lifestyle diseases using machine learning techniques. You can learn hardware development of optical measurement systems for evaluating human physiological function. Good knowledge of the medical statistical analysis techniques could be obtained through the data analysis and discussion with the medical doctors and sports physiologists in the project team.

Suggested readings:

- Ono, Y., Esaki, K., Takahashi, Y., Nakabayashi, M., Ichinose, M., & Lee, K. (2018). Muscular blood flow responses as an early predictor of the severity of diabetic neuropathy at a later stage in streptozotocin-induced type I diabetic rats: a diffuse correlation spectroscopy study. *Biomedical optics express*, 9(9), 4539-4551.
- Ono, Y., Nakabayashi, M., & Ichinose, M. (2021, October). Diffuse Optics for Probing Oxygen Metabolism of Active Muscles. In *2021 IEEE Photonics Conference (IPC)* (pp. 1-2). IEEE. (Invited symposium paper) The presentation file for the introduction of DCS-NIRS is also attached.

¹ DCS: diffuse correlation spectroscopy, NIRS: near-infrared spectroscopy