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Congratulations to New ICFO PhD Graduate

Dr. Lisa Kobayashi Frisk graduated with a thesis entitled ?Application and development of diffuse optical methods for the non-invasive bedside assessment of cerebral hemodynamics in the stroke unit'

July 14, 2023

We congratulate : Dr. Lisa Kobayashi Frisk who defended his thesis today in ICFO's Auditorium.
Dr. Kobayahi obtained her MSc in Photonics at Lund University (SE). She joined the Medical Optics research group at ICFO led by ICREA Prof. Dr Turgut Durduran as a PhD student.
Dr. Kobayahi's thesis entitled ?Application and development of diffuse optical methods for the non-invasive bedside assessment of cerebral hemodynamics in the stroke unit' was supervised by Prof. Turgut Durduran.

ABSTRACT:
The brain is an organ with a large energy budget compared to its volume and weight and constantly requires oxygen-rich blood to meet its metabolic needs. Given this fact, a tool that enables the continuous non-invasive monitoring of cerebral hemodynamics would be an important addition to a clinician's toolbox. In this thesis, I focus on stroke, a disease in which cerebral blood flow is impaired in different regions of the brain.
Hybrid diffuse optical techniques are capable of the non-invasive measurement of regional cerebral hemodynamics. The main objectives of this PhD thesis were to demonstrate th potential utility of diffuse optical techniques in stroke patients as well as to advance th technology to become more portable and less expensive with the capability of measurin hemodynamics with a greater precision and accuracy.
In the first part of the thesis, I report on data from a randomized controlled trial which monitored the cerebral hemodynamics in one hundred-and-six stroke patients during first mobilization using two optical techniques: time-resolved near-infrared spectroscopy (TRS) and diffuse correlation spectroscopy (DCS). The aim of the clinical trial was to determine whether cerebral hemodynamics measured during mobilization could be used as biomarkers for individualizing mobilization therapies.
In the first set of results, the cerebral hemodynamic response to mobilization and posture

change was characterized. In the second set of results, cerebral autoregulation was assessed during first mobilization and was found to be associated with neurological deterioration. These results suggest that patients with impaired cerebral autoregulation during mobilization should perhaps avoid further mobilization in the early hours post-stroke. In the third set of results, the safety and efficacy of standard and intensive mobilization therapy was compared. No differences were found, and cerebral autoregulation status was no associated with neither safety nor efficacy outcome variables.

The clinical portion of the thesis is an example of the potential application and demonstrates the value of non-invasive measurements of cerebral hemodynamics at the bed-side. However, a major disadvantage of current diffuse optical technologies is the difficulty in acquiring data with a high signal to noise ratio (SNR) in areas with higher probability of absorption, e.g. in regions covered by hair. In the context of stroke patients, this limits measurements to anterior hemodynamics irrespective of the location of the stroke.

The second part of the thesis consists of the development of another diffuse optical technique (speckle contrast optical spectroscopy/tomography (SCOS/SCOT)) that may be able to overcome this limitation. As a first step, a simulation model was developed to model the generation and acquisition of the speckle contrast signal. This model allowed for the study of the properties of the speckle contrast signal both in terms of detection an measured tissue parameters. In addition, the simulation model allows for the definition o certain measurement goals to achieve a predetermined acquisition accuracy and precision Then, a prototype device was built that is not only cheaper and more portable than mor standard diffuse optical technologies, but also has a high SNR. The device was characterized and the measurement goals for accuracy were established. Finally, I developed an analys s method for extracting blood flow data from SCOS signals. This method allows for he simplification of system designs and/or protocols and can also increase data acquisit on frequencies.

This thesis covers a range of topics from clinical research to simulation models and system design. However, the overall contribution of this work is to demonstrate the clinical utility of these techniques as well as to propel the technology further to achieve a more complete picture of cerebral health.

THESIS COMMITTEE:

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