PhD Thesis Defense MARCO PAGLIAZZI 'Time Domain, Near-Infrared Diffuse Optical Methods for Path Length Resolved, Non-Invasive Measurement of Deep-Tissue Blood Flow'

MARCO PAGLIAZZI

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Friday, October 4, 11:00. ICFO Auditorium

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Medical Optics

ICFO

The non-invasive and, often, continuous measurement of the hemodynamics of the body,

and for the main purposes of this thesis, the brain, is desired because both the instantaneous values and their changes over time constantly adapt to the conditions affecting the body and its environment. They are altered in pathological situations and in response to increased function. It is desirable for these measurements to be continuous, reliable, minimally invasive, and relatively inexpensive. In recent years, optical techniques that, by using diffusing and deep-reaching (up to few centimeters) light at skin-safe levels of intensity, combine the aforementioned characteristics, have increasingly become used in clinical and research settings. However, to date there is, on one side the need to expand the number and scope of translational studies, and, on the other, to address shortcomings like the contamination of signals from unwanted tissue volumes (partial volume effects). A further important goal is to increase the depth of penetration of light without affecting the non-invasive nature of diffuse optics.

My PhD was aimed at several aspects of this problem; the development of new, more advanced methods, i.e. the time/pathlength resolved, to improve the differentiation between superficial and deeper tissues layers, (the exploration of new application areas, i.e. to characterize the microvascular status of bones, to study the functional response of the baby brain, and to improve the quality control of the systems, i.e. by introducing a long shelf-life dynamic phantom.
In conceptual order, first I introduce long shelf-life reference standards for diffuse correlation spectroscopy. Secondly, I describe the use of an existing hybrid time domain and diffuse correlation spectroscopy system to monitor the changes that some pathological conditions, in this case osteoporosis and human immunodeficiency virus infection, may have on many aspects of the human bone tissue that are currently not easy to measure (i.e. invasively assessed) by conventional techniques. Thirdly, I describe the development of a novel time domain optical technique that intimately combines, introducing many previously unmet advancements, the two previously cited optical spectroscopy techniques. For the first time I was able to produce a time domain device and protocol that can monitor the blood flow in vivo in the head and muscles of healthy humans. Lastly, I describe a device and method that I have used to monitor changes in blood flow in healthy human infants of three to five months of age, for the first time in this age bracket, as a marker of activation following visual stimulation.

Overall, this work pushes the limit of the technology that makes use of diffuse light to minimally invasively, continuously, and reliably monitor endogenous markers of pathological and physiological processes in the human body.

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