PhD Thesis title: 'Hybrid diffuse optics for monitoring of tissue hemodynamics with applications in oncology'

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ABSTRACT:

Noninvasive measurement of hemodynamics at the microvascular level may have a great impact on oncology in both clinical, i.e. diagnosis, therapy planning and monitoring, and, in preclinical studies. To this end, diffuse optics is a strong candidate for noninvasive, repeated, deep tissue monitoring.

In this multi-disciplinary, translational work, I have constructed and deployed hybrid devices which are the combination of two qualitatively different methods, near infrared diffuse optical spectroscopy (NIRS) and diffuse correlation spectroscopy (DCS), for simultaneous measurement of microvascular total hemoglobin concentration, blood oxygen saturation and blood flow.

In a preclinical study, I applied the hybrid device to monitor the response of renal cell carcinoma in mice to antiangiogenic therapy. The results suggest that we can predict the output of therapy from early hemodynamic changes, which provide us with valuable information for better understanding of the tumor resistance mechanism to antiangiogenic therapies.

In two *in vivo* studies in human volunteers, I have developed protocols and probes to demonstrate the feasibility of noninvasive diffuse optical spectroscopy to investigate the pathophysiology of bone. First study was study on the physiology of the patella microvasculature, the other introduced the manubrium as a site that is rich in red bone marrow and accessible to diffuse optics as a potential window to monitor the progression of hematological malignancies.

Overall, during my Ph.D., I have developed instrumentation, algorithms and protocols and, then, applied this technique for preclinical and clinical investigations. My research is a link between preclinical and clinical studies and it opens new areas of applications in oncology.

References to author publications that relate specifically to the dissertation:

Peer-reviewed articles

[1] **P Farzam**, P Zirak, T Binzoni, and T Durduran. Pulsatile and steady-state hemodynamics of the human patella bone by diffuse optical spectroscopy. Physiological Measurement, 34(8):839–57, June 2013. doi:10.1088/0967-3334/34/8/839

[2] **P Farzam**, C Lindner, U Weigel, M Suarez, A Urbano-Ispizua, and T Durduran. Noninvasive characterization of the healthy human manubrium using diffuse optical spectroscopies. Physiological Measurement, 35(7):1469–1491, June 2014. doi:10.1088/0967-3334/35/7/1469

[3] **P Farzam** and T Durduran. Multidistance diffuse correlation spectroscopy for simultaneous estimation of blood flow index and optical properties. Journal of Biomedical Optics, 20(5), 055001, May 2015. http://dx.doi.org/10.1117/1.JBO.20.5.055001