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Light for life – Optical spectroscopy in clinical settings †

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Abstract: Diagnosing diseases in our bodies requires measurement of physiological biomarkers non-invasively. Assessing the biomarker levels is a key step in this process. Light allows for non-invasive assessment of the disease in the tissue.

Here, I give my perspective of the use of light for diagnosis with examples of research conducted in our research team, focusing on two conditions – oral cancer and fetal hypoxia diagnosis. In the case of oral cancer we look at the spatially localized diagnosis or cancer tissue in the oral cavity. In the case of fetal hypoxia, we look at temporal change in physiological conditions for diagnosis. In both cases, we see the potential transformative impact of optical spectroscopy on clinical diagnosis.

Keywords: BioPhotonics, Diffused reflectance, near infrared spectroscopy, clinical diagnosis

1. Summary

The human body is composed of different biomolecules. Broadly they are classified into four large groups of carbohydrates, fats, proteins and nucleic acids with minor concentrations of other signaling molecules like hormones etc. The interplay between them allows for normal healthy lifestyle and physiology. During a diseased state, the composition of some of the biomolecules departs from the levels in a healthy physiology. This shift from normal is the basis of clinical diagnosis like blood tests, imaging techniques etc. The clinical diagnostics are frequently invasive, cumbersome and not continuous. There is a need for repeated, reliable, non-invasive assessments of diseases like cancer, diabetes, sepsis etc.

One approach to realize a continuous, non-invasive diagnostic tool is to use the fact that different biomolecules interact with light differently, that is to look at the light-tissue interaction. Different wavelengths of light interact with biomolecules differently exciting their electronic transition or rotational or vibrational modes of their chemical bonds. Thus, different biomolecules have their unique fingerprints when interacting with light. While certain wavelengths of light like X-Rays and far UV are harmful to the tissue due to ionization, it is possible to deliver safe, controlled doses of light to assess the concentrations of biomolecules in tissues. Different light-tissue interactions, like diffuse reflectance, fluorescence and Raman spectroscopy provide a BioPhotonics toolbox to discern healthy tissue from unhealthy tissue in a clinic. It is also possible to continuously monitor the biomolecule concentrations to observe the transition from healthy condition to a diseased physiology.

Here, I discuss two projects in our group (BioPhotonics at Tyndall) that I am involved in where such Biophotonics tools are used to distinguish between healthy and unhealthy clinical situations as shown conceptually in Figure 1. In the first project we use a multimodal approach to classify cancerous and healthy tissue spatially in a clinic in various

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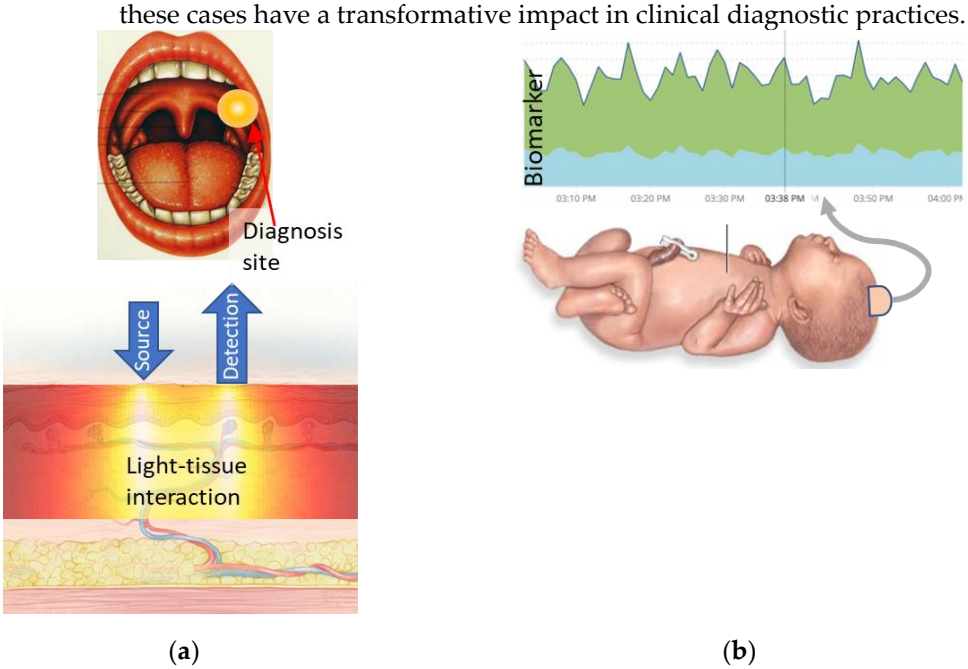
lesions in the oral cavity [1]. In another project, we are looking at the changes in biomolecule concentrations over time during labour to monitor the onset of hypoxia in the babies [2]. The intention is to research and develop diagnostic tools to find malignant lesions earlier and with a higher accuracy, and to accomplish a tool for help diagnose fetal distress during labour that would result in a safer delivery, both for mother and infant. Both these cases have a transformative impact in clinical diagnostic practices.



(**a**) (**b**)

Figure 1. BioPhotonics tools for diagnosis of diseases. **(a)** - Spatial assessment of legions. **(b)** - Temporal monitoring of hypoxia in babies.

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Conflicts of Interest: The authors declare no conflict of interest

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