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Validating Hemoglobin Saturation and Dissolved Oxygen in Tumors using Photoacoustic Imaging and the OxyLab Probe

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ABSTRACT

The goal of this experiment is to validate the relationship between hemoglobin saturation (SaO_2) and partial pressure of dissolved oxygen (pO_2) in breast tumors in mice using photoacoustic computed tomographic (PCT) imaging and OxyLite probe, respectively. In its simplest form, the relationship is described by the dissociation curve, or Hill's equation, for hemoglobin, and is modeled as a sigmoidal curve that is a function of two parameters – the Hill coefficient, n, and the net association constant of HbO_2, K (or pO_2 at 50% SaO_2). First, a calibration study to validate Hill's equation in blood was performed by creating a closed circuit phantom to test the SaO_2 (co-oximeter) and pO_2 (Oxylite probe) relationship (K=23.2mmHg and n=2.26). Next, non-invasive localized measurements of SaO_2 in MDA-MD-231 and MCF7 breast tumors using PCT spectroscopic methods were compared to pO_2 levels, where pO_2 levels were measured in 1mm increments across the central axis of the tumor. The fitted results for MCF7 and MDA-MD-231 were K=17.2mmHg and 20.7mmHg, and n=1.76and 1.63, respectively. The results are consistent with sigmoidal form of Hill's equation. The lower value of K is indicative of the acidic microenvironment associated with tumors. Ongoing work to correct for photon transport and image artifacts are anticipated to enhance the quality of the results. In conclusion, the results from this study demonstrate photoacoustic can be used to measure tumor oxygenation, and its potential use in investigating the effectiveness of anti-angiogenesis therapy.
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KEYWORDS

Hemoglobin saturation, partial pressure, dissolved oxygen, oxygen probe, photoacoustic, imaging, breast tumors, MCF7, MDA-MD231

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