Purpose:The goal is to develop a method to non-invasively assess intra-tumor pO2 using photoacoustic imaging. It is well established that the oxygen status of a tumor plays a critical role in the therapeutic response and resistance, resulting in treatment failure and poor disease-free and overall survival. Clinical techniques, such as polarographic electrode, photoluminescence-quenching, or pimonidazole, are invasive and lack the patho-physiological etiology leading to hypoxia. A biophysical model is proposed to determine local pO2 based on fusing hemodynamic measurements acquired from dynamic contrast-enhanced and spectroscopic photoacoustic imaging (DCE-PCT and PCT-S).

Methods:MCF7 and MCF7/VEGF xenograft breast tumors were first scanned within a prototype PCT scanner to obtain parametric maps of oxygen saturation and hemoglobin concentration and within a clinical CT scanner to obtain dynamic contrast-enhanced data (DCE-CT) to obtain parametric maps of perfusion, fractional-plasma-volume, and fractional-interstitial-volume. These maps were fused based on a mathematical model of tissue oxygen delivery, and compared to measurements taken with an OxyLite probe. To replace DCE-CT, a new generation of PCT scanner was developed to acquire DCE-PCT data and realize physiological maps. Mice with MDA-MB-231 xenograft breast tumors were i.v. injected with ICG, and scanned prior to and every 12-seconds for up to 4-minutes and at 15-minutes post-injection. These contrast-enhance curves were fit compartmental models to obtain maps of tumor perfusion and fractional plasma volumes.

Results:Preliminary results comparing pO2 measurements implementing biophysical models and PCT-S and DCE-CT and OxyLite probe measured a linear correlation of R2=0.82, and a slope of 0.975(±0.10) and an intercept of -0.093(±2.2)mmHg. The first parametric maps of tumor perfusion and fractional plasma volume using DCE-PCT will be presented and compared to DCE-CT, and ICG kinematics identifying regions of high extravasation.

Conclusions:A biophysical model of pO2 based on hemodynamic data and physiological maps in breast tumors obtained from photoacoustic imaging has been demonstrated.

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