AbstractID: 9520 Title: A comparative study of a stochastic tumor vasculature simulation model.

Purpose:

Micro vessel density dictated by the oxygen concentration is one of the most important biomarkers used for cancer recurrence. This work aims at simulating a representative map of tumor micro-vasculature and observes the growth of vasculature with respect to two simulation parameters: oxygen concentration and vessel coverage.

Method and Materials:

The tissue volume was simulated as a 3-dimensional matrix in MATLAB. A corresponding matrix containing oxygen concentration data determines the regional micro-vascular density. The vasculature map was simulated via stochastic modeling governed by the following two factors:

- **(a)** A region of higher oxygen concentration indicates a higher capillary concentration; vessels are simulated to grow along increasing oxygen gradients, so that the final vasculature developed has a greater vessel concentration in these regions.
- **(b)** The vessels avoid other vessels so that they can effectively cover the tissue volume.

The simulations were carried out varying the degree of competition between the two factors. This vasculature simulation model was tested for various oxygen map scenarios and applied to experimental mouse data of known vasculature and oxygenation concentration obtained via hypoxia imaging.

Results:

While a simulation partial to vessel coverage yielded a vasculature incapable of showing the general trend of oxygen gradients, a simulation partial to oxygen gradients yielded an unrealistic vasculature unable to cover the tissue volume effectively. When balanced, the two factors yielded a vasculature which demonstrated the general trend of oxygen gradients and micro-vessel density coverage as determined by the oxygenation mask. The model tested against experimental mouse data from micro-PET/CT images and yielded a suitable comparative vessel structure.

Conclusion:

A balance between the two driving factors is essential for the growth of a proper microvasculature. The model is a prospective tool for investigating functional dependencies between tumor growth and angiogenesis.