Investigation of the Dynamics of Magnetic Nanoparticles for Targeting and Probing the Microenvironment of Cancerous Cells and Tissues

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Objective

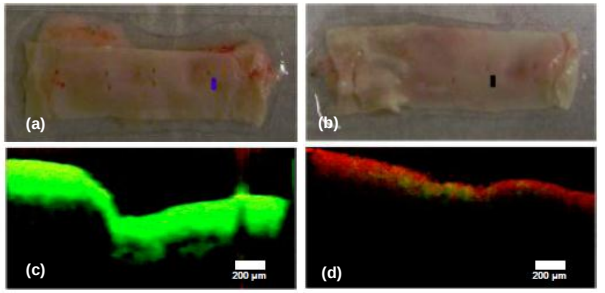
Magnetic nanoparticles can be perturbed by an external magnetic field and the resultant displacements can be optically measured with nano-scale accuracy to provide not only dynamic contrast in imaging but to also assess the biomechanical properties of the microenvironment. The objective of this project is to study the dynamics and targeting of these magnetic agents to cancerous cells and tissues under different flow conditions and magnetic field modulations.

Research Highlights

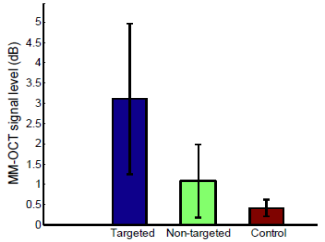
- Dependency of the magneto-motive signal on magnetic particle concentration and microenvironment stiffness was investigated using magneto-motive optical coherence tomography (MM-OCT).
- Microspheres containing magnetic nanoparticles were functionalized to target the $\alpha_v\beta_3$ integrin that are overexpressed during angiogenesis. We demonstrated targeting of these microspheres by perfusing blood vessels overexpressing the $\alpha_v\beta_3$ integrin in a custom designed flow chamber at physiologically relevant pulsatile flow rates and showed that modulating these magnetic particles by external magnetic fields can significantly enhance the contrast .

Future Research

- Developing a catheter-based MM-OCT imaging system that can enable *in vivo* tracking and visualization of magnetic particles.



Rabbit aorta segments overexpressing the $\alpha_v\beta_3$ integrin perfused with (a) targeted and (b) non-targeted microspheres. The blue and black colored regions correspond to the MM-OCT cross-sectional images shown in (c) and (d) respectively.
The increase in contrast shown in (c) compared to (d) demonstrates successful targeting under flow conditions and the ability of MM-OCT to detect the presence of the microspheres



MM-OCT signal values between targeted, non-targeted, and control specimens