Light and sound: can ultrasound become the preferred imaging modality for molecular medicine?

Matthew O'Donnell

Department of Bioengineering, University of Washington, Seattle, WA, 98195

Optoacoustics can be used to image the distribution of optical absorption in tissue, combining the specificity and sensitivity of optical imaging with the high resolution and penetration of ultrasound imaging. It represents one of the most promising techniques for molecular imaging because the optical absorption of bioconjugated nanoparticles can greatly exceed that of tissue over a range of wavelengths in which light can penetrate multiple centimeters into the body. We have explored several types of nanoparticles conjugated to a range of antibodies targeted to several important biological systems. Here we discuss two potential applications of bioconjugated gold nanorods, one for cancer cell targeting and the other to identify inflamed endothelial cells signaling the early stages of atherosclerosis. Optoacoustic images of cell cultures and animal models demonstrate the sensitivity and specificity of these nanosystems for molecular imaging.

To translate these experimental findings into a clinically acceptable molecular imaging modality, we have also explored integrated optical systems able to deliver the optical pulse for optoacoustic excitation and detect the resultant ultrasonic waves using an all-optical transducer. The basic operating principles of this device, and the prospects for ultrasound-based molecular imaging using it, will be discussed.