FACT SHEET

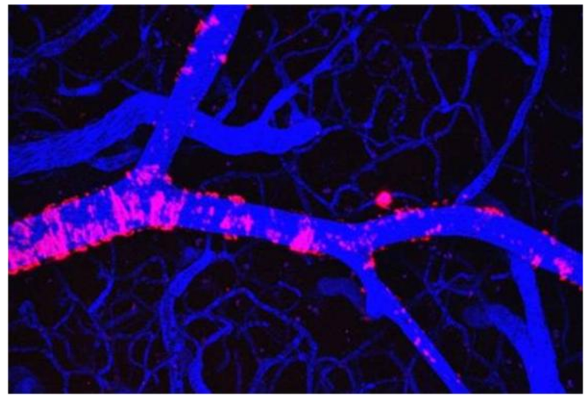
NATIONAL INSTITUTES OF HEALTH

Optical Imaging

Optical Imaging is an emerging technology with great potential for improving disease prevention, diagnosis, and treatment in the medical office, at the bedside, or in the operating room. Optical imaging offers a number of important advantages over existing radiological imaging techniques. First, optical imaging uses non-ionizing radiation, which significantly reduces patient radiation exposure and allows for repeated studies over time. Second, optical imaging offers the potential to differentiate among soft tissues, and between native soft tissues and tissue labeled with either endogenous or exogenous contrast media, using their different photon absorption or scattering profiles at different wavelengths. Such a rich environment of photon absorption and scattering differences offers a great potential for providing specific tissue contrasts, and offers potential capabilities for studying functional and molecular level activities that are the basis for health and disease. Third, optical imaging is very amenable to multimodal imaging. It extends over a wide range on the imaging resolution scale and is often complimentary to and easily combinable with other imaging techniques.

Yesterday

- During the last 15 years, rapid advances and developments in *biophotonics* (the science and technology of the interaction of photons within and on biological systems) have resulted in promising new imaging techniques with broad applications in high-resolution imaging.
- Advances in lasers that produce very short (durations measured in fractions of a trillionth of a second), very intense light pulses and other light technology advances make possible the development of instruments at moderate costs.
- Advances in genetics and genomics spurred applications to image cellular activity, such as visualization of gene expression in real-time, as well as detection of protein synthesis during biologic processes. The ability to probe physiology and molecular function using optical imaging enhances diagnostic accuracy and plays a vital role in therapeutic strategy and monitoring.



Optical imaging of amyloid deposits (red) in living mouse brain blood vessels in a mouse model of Alzheimer's Disease. *Garcia-Alloza et al., J. Neurochem., 2007.*

Today

- Recently, techniques transferred from the laboratory to the clinic resulted in the development of a broad variety of diagnostic technologies and applications, in particular imaging of the breast and the adult and infant brain. For example:
  - To improve the accuracy of surgical biopsies, NIH-supported researchers used tiny-fiber optic probes to detect malignant tissues. Women confronting breast cancer may soon have a more accurate test without undergoing painful surgical biopsies. Moreover, the number of cancers that go undetected could be reduced.
  - NIH-funded researchers are using optical coherence tomography (OCT) to develop methods to identify vulnerable coronary plaques associated with heart disease and to accurately guide placement of treatment probes in deep-brain structures for the treatment of Parkinson's disease.

- Researchers are developing techniques to study the margins of skin cancers during the surgery to microscopically determine when all the abnormal cells have been removed.
- Modalities such as multiphoton microscopy are being used to study living cells and tissues without inflicting damage. This technique is used to study amyloid plaques associated with Alzheimer's disease and fibrous collagen deposits associated with many liver diseases.

Tomorrow

- The ability to image, analyze, and manipulate living tissue at the cellular and molecular levels will enhance the practice of medicine, making it more predictive, personalized, and preemptive. Imaging techniques will be integrated with therapy allowing first the identification of diseased tissue followed by the optically-mediated releases of therapy directly at the target site. Further transfer of these new techniques into clinical tools remains a demanding problem and requires close collaboration between imagers, engineers, clinicians, mathematicians, and basic scientists. To advance this important field, the NIH remains committed to funding in vivo optical imaging translational research.

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