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Multi-Functional In Vivo Cardiovascular Imaging Using Near-Infrared II Fluorescence

Stanford researchers have proposed a novel, in vivo, real-time epifluorescence imaging method in the second near-infrared region using single-walled carbon nanotubes (SWNTs). This method provides both anatomical and hemodynamic information at high spatial and temporal resolutions and in real time. The feasibility of this technology has been demonstrated in animal models, in which small vessel imaging is achieved. Arterial and venous vessels are unambiguously differentiated, and precise quantifications of blood velocity and flow in both normal and ischemic vessels have been determined. This is the first time a 2D surface-weighted, semi-quantitative epifluorescence imaging method achieved high resolution vessel imaging, vessel type differentiation and flow quantification.

Stage of Research:
Successfully demonstrated in animal models. In vivo real-time epifluorescence imaging of mouse hind limb vasculatures in the second near-infrared region (NIR-II) is performed using single-walled carbon nanotubes as fluorophores.
Results show high spatial (?30 ?m) and temporal (200 ms per frame) resolution for small-vessel imaging at 1-3 mm deep in the hind limb owing to the beneficial NIR-II optical window that affords deep anatomical penetration and low scattering.

Applications

- **Biology** - for preclinical imaging of animal models of cardiovascular disease to gain insights on changes in anatomy or blood flow over time.
- **Medicine**- to be used by physicians to image patients to acquire anatomical and/or physiological information regarding superficial structures, such as the cutaneous or retinal vasculature.

Advantages

- Multimodal, fast, real-time images.
- Higher spatial resolution, deeper anatomical penetration, and reduced tissue scattering compared to traditional NIR-I imaging.
- In small animal models, higher spatial and temporal resolution compared to CT; no radiation; provides additional information on hemodynamics and is able to easily distinguish arteries and veins.
- This method superior to ICG imaging at 800nm, already in use for various diseases ranging from skin diseases to sentinel lymph node imaging for cancer

Publications

- US Patent Application Serial No. 14/443,899.
- Hong G. Through Skull Fluorescence Imaging of the Brain in a New Near-Infrared Window. *Nature Photonics* Published online 03 August 2014.
- Hong G. et al. Ultrafast fluorescence imaging in vivo with conjugated polymer fluorophores in the second near-infrared window. *Nature Communications* Published 20 June 2014.
- Hong G, Lee JC, Robinson JT, Raaz U, Xie L, Huang NF, Cooke JP, Dai H. "Multi-Functional In Vivo Vascular Imaging Using Near-Infrared II Fluorescence." Nature Medicine 2012 Dec 6;18(12):1841-6.

Patents

- Published Application: WO2014081419
- Published Application: 20150297086
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