Advanced magnetic resonance imaging technology to track cells in the body

March 14 2016

The need to non-invasively 'see' and track cells in living persons is indisputable - a boon to both research and development of future therapies. Emerging treatments using stem cells and immune cells are poised to most benefit from cell tracking, which would visualize their behavior in the body after delivery. Clinicians require such data to speed these cell treatments to patients.

Writing in the March 14, 2016 online issue of *Nature Materials*, researchers at University of California, San Diego School of Medicine describe a new, highly sensitive chemical probe that tags cells for detection by magnetic resonance imaging (MRI).

Specifically, a research team led by senior author Eric T. Ahrens, PhD, professor of radiology, and Roger Tsien, PhD, professor of pharmacology, chemistry and biochemistry (whose work with fluorescent proteins earned him a share of the 2008 Nobel Prize in chemistry) have synthesized a new cell labeling probe using fluorine-19, the stable isotope of the element fluorine. Agents are formulated as a "nanoemulsion" that contains microscopic droplets of an inert fluorine-based agent that is taken up by cells of interest. The fluorine agent in cells is directly detected by MRI, enabling one to observe movement of cell populations.

"Fluorine-19 tracer agents are an emerging approach that produces positive signal hot-spot images with no background signal because there's virtually no fluorine concentration in tissues," said Ahrens. "We

have made a major leap in sensitivity. We have figured out how to dissolve and encapsulate metals inside the fluorine-based droplets. The net effect is to greatly amp up the MRI signal."

Ahrens, Tsien and Alex Kislukhin, a postdoctoral scholar in their labs, increased the sensitivity of the fluorine MRI agent by creating a new imaging medium that combines highly fluorinated nanoemulsions with the magnetic properties of metals - a technique that increases the visibility of fluorine by MRI. Unexpectedly and serendipitously, they also discovered that iron is particularly effective at enhancing the fluorine MRI signal.

"The chemist's iron hand has moved the field of biomedical imaging forward," said Ahrens. "To the best of our knowledge, iron has never been considered as an enhancer of 19F MRI signals, yet our analysis shows that iron is fundamentally magnetically superior to all other metal ions for enhancing fluorine MRI."

Added Tsien: "It's a wonderful coincidence that fluorine MRI benefits most from iron, which is biologically friendlier and cheaper than gadolinium, still the favorite for proton MRI."

While more research remains to be done, Ahrens said 19F MRI aided by iron represents a significant advance in tracking cells in many emerging therapeutic areas, such as immunotherapy, stem cells and treating inflammation.

More information: Paramagnetic fluorinated nanoemulsions for sensitive cellular fluorine-19 magnetic resonance imaging, *Nature Materials*, DOI: 10.1038/nmat4585

Provided by University of California - San Diego