'Gadonanotubes' greatly outperform existing MRI contrast agents

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Researchers at Rice University, the Baylor College of Medicine, the University of Houston and the Ecole Polytechnique Fédérale de Lausanne in Switzerland have created a new class of magnetic resonance imaging (MRI) contrast agents that are at least 40 times more effective than the best in clinical use.

The new agents -- dubbed gadonanotubes -- use the same highly toxic metal, gadolinium, that is given to more than a quarter of MRI patients today, but the metal atoms are encased inside a hollow tube of pure carbon called a nanotube. Shrouding the toxic metals inside the benign carbon is expected to significantly reduce or eliminate the metal's toxicity.

The research was published this month in the journal Chemical Communications .

"In prior work, we have boosted the effectiveness of gadolinium MRI contrast agents by encasing them in spheres of carbon called buckyballs," said lead author Lon Wilson, professor of chemistry at Rice. "Each nanotube will hold more gadolinium atoms than a buckyball, so we expected them to be more effective agents. But they are actually much, much better than we anticipated, so much so that no existing theory can explain how they work."

Wilson and colleagues use short segments of nanotubes, tiny cylinders of pure carbon about one billionth of a meter, or one nanometer, in

diameter. That's about as wide as a strand of DNA. The ultrashort segments are only about 20-100 times longer than they are wide, and once inside the nanotubes, the gadolinium atoms naturally aggregate into tiny clusters of about 10 atoms each. Wilson and colleagues suspect the clustering is causing the unexplained increases in magnetic and MRI effects that they observed in tests at Rice, at the University of Houston's Texas Center for Superconductivity, and in the Swiss laboratories.

More than 25 million patients in the U.S. undergo MRIs each year. Doctors use contrast agents in about 30 percent of MRIs. The contrast agents increase the sensitivity of the scans, making it easier for doctors to deliver a diagnosis. Gadolinium agents are the most effective agents and the most commonly used.

In the future, the researchers hope to use existing methods of attaching disease-specific antibodies and peptides to gadonanotubes so they can be targeted to cancerous tumors and other diseased cells.

Co-authors include Rice's Balaji Sitharaman, Kyle Kissell, Keith Hartman and Lesa Tran; the University of Houston's Andrei Baikalov, Irene Rusakova and Yanyi Sun; the Baylor College of Medicine's Htet Khant, Steven Ludtke and Wah Chiu; and the Ecole Polytechnique Fédérale's Sabrina Laus, Eva Tóth, Lothar Helm and André Merbach.