Nanoparticles aid bone growth

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In the first study of its kind, bioengineers and bioscientists at Rice University and Radboud University in Nijmegen, Netherlands, have shown they can grow denser bone tissue by sprinkling stick-like nanoparticles throughout the porous material used to pattern the bone.

The research is available online and slated to appear in the journal *Bone*. It's the latest breakthrough from the burgeoning field of tissue engineering. The new discipline combines the latest research in materials science and biomedical engineering to produce tissues that can be transplanted without risk of rejection.

To grow new bone, tissue engineers typically place bone cells on porous, biodegradable materials called scaffolds, which act as patterns. With the right chemical and physical cues, the cells can be coaxed into producing new bone. As the scaffold degrades, it is replaced by new bone.

"Ideally, a scaffold should be highly porous, nontoxic and biodegradable, yet strong enough to bear the structural load of the bone that will eventually replace it," said lead researcher Antonios Mikos, Rice's J.W. Cox Professor in Bioengineering, professor of chemical and biomolecular engineering and the director of Rice's Center for Excellence in Tissue Engineering. "Previous research has shown that carbon nanotubes give added strength to polymer scaffolds, but this is the first study to examine the performance of these materials in an animal model."

In the experiments, the researchers implanted two kinds of scaffolds into

rabbits. One type was made of a biodegradable plastic called poly(propylene fumarate), or PPF, which has performed well in previous experiments. The second was made of 99.5 percent PPF and 0.5 percent single-walled carbon nanotubes. Nanotubes are about 80,000th the width of a hair. While they are normally about a thousand times longer than they are wide, the researchers used shorter segments that have fared well in prior cytocompatibility studies.

Half the samples were examined four weeks after implantation and half after 12 weeks. While there was no notable difference in performance at four weeks, the nanotube composites exhibited up to threefold greater bone ingrowth after 12 weeks than the PPF. Furthermore, the researchers found the 12-week composite scaffolds contained about two-thirds as much bone tissue as the nearby native bone tissue, while the PPF contained only about one-fifth as much.

Mikos said the nanocomposites performed better than anticipated. In fact, the results indicate that they may go beyond passive guides and take an active role in promoting bone growth.

"We don't yet know the exact mechanism of this enhanced bone formation, but we have intensive studies under way to find out," Mikos said. "It could be related to changes in surface chemistry, strength or other factors."

Source: Rice University