Smart orthopedic implants, self-fitting tissue scaffolding created by UMMS researchers

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Orthopedic surgeons are often hamstrung by less-than-ideal grafting material when performing surgeries for complex bone injuries resulting from trauma, aging or cancer. Conventional synthetic bone grafts are typically made of stiff polymers or brittle ceramics, and cannot readily conform to the complex and irregular shapes that often result from injury; in addition, they often require metallic fixation devices that require open surgeries to insert and remove. Ideally, a scaffolding graft would conform to complex shapes of an injury site, provide weight-bearing support, require less invasive surgical delivery, and ultimately disappear when no longer needed.

Using a nanoparticle core, Jie Song, PhD, assistant professor of orthopedics & physical rehabilitation and cell biology at the University of Massachusetts Medical School, and postdoctoral fellow Jianwen Xu, have fashioned a new type of tissue and bone scaffolding polymer that addresses a number of these long-standing limitations. Research published in the online Early Edition of *Proceedings of the National Academy of Sciences*, describes the development of a class of heat-activated smart materials that combine tissue-like properties and strength that are clinically safe to deploy and able to integrate with surrounding tissue.

The key feature of the new polymer is its heat-activated malleability and shape memory. Using CT scans and MRI images of the injury site, Song envisions physicians creating a polymer mold of the scaffolding needed to stabilize a skeletal injury site, in the lab, prior to surgery. Heat activated at a safe 50°C, the smart polymer could then be reshaped to a more compressed form suitable for insertion in the body through a small, minimally invasive incision. Once at the injury site, the idea is to then thermally re-activate the polymer to cause it to revert to its original, pre-molded shape in seconds, according to Song.

In addition to providing mechanical stabilization to the skeletal structure, because the biodegradable material is similar to those used in dissolvable sutures, it can be safely reabsorbed by the body as it breaks down over time. Therefore, there is no need for a second surgery to remove the implant. Additionally, as the scaffolding degrades, the polymer provides a porous structure that promotes tissue growth and integration. At the same time, the polymer has the ability to deliver therapeutics to accelerate new bone growth and integration.

"Strong and resorbable smart implants could have paradigm-changing impact on a number of surgical interventions that currently rely on the use of more invasive and less effective metallic cages, fixators and stents," said Song. "From spinal fusion to alleviate chronic lower back pain, vertebroplasty for treating vertebral fractures to angioplasty for widening narrowed or obstructed blood vessels, there are tremendous clinical applications for smart polymers."

Song and colleagues are testing the safety and efficacy of the material in animal models, which they hope will pave the way for future clinical trials.

Provided by University of Massachusetts Medical School

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