Medical Xpress

Researchers study how to regrow long bone segments using 3-D printing

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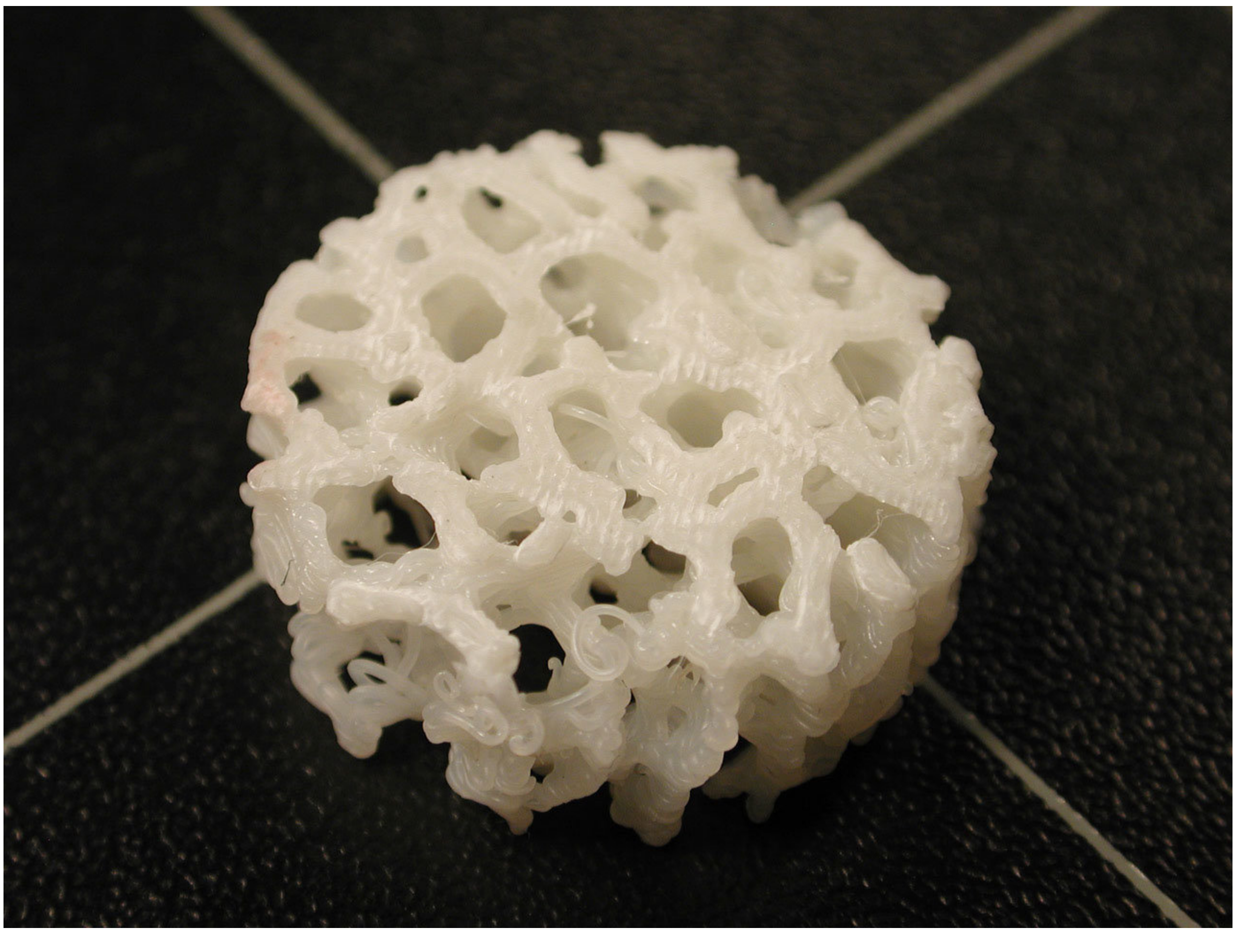

Close-up of a 3D printed scaffold, a plastic bone-shaped frame that will help replace missing bone. Credit: John Szivek, Ph.D. / UA College of Medicine - Tucson

Not all broken bones heal. But one scientist at the University of Arizona hopes to remedy that problem using a combination of 3-D printing and adult stem cells.

"Imagine an impact that causes half of a long bone to shatter so that it can't be put back together—no current surgical treatment can ensure that kind of injury will heal," explained John A. Szivek, Ph.D., a scientist at the UA College of Medicine—Tucson. "This is a really big problem for the military, where explosions or combat injuries can cause big bone defects."

To help military personnel with these devastating injuries, Dr. Szivek, a biomedical engineer and professor of orthopedic surgery, has received a five-year, $2 million grant from the U.S. Department of Defense to launch a study to determine how to heal bone fractures using a combination of 3-D printing and adult stem cells.

With the help of clinical partners in the UA Department of Orthopaedic Surgery, Dr. Szivek's lab plans to 3-D print scaffolds—plastic bone-shaped frames—that can replace large, missing or broken bone segments. These scaffolds will be filled with calcium particles and adult stem cells, two key elements that lead to much faster healing and bone growth.

Once implanted, the scaffold will serve as a template for the bone to grow on.

Pilot studies in Dr. Szivek's lab have shown this technique works well. "We achieved complete bone formation, covering a large bone defect in about three months. Now we want to make that healing process even faster," he said.

The team will test whether exercise early in the healing process can help speed up healing and recovery.

"Studies have shown that exercise makes your bones grow, so maybe we can make bone on our scaffolds grow even faster with exercise," Dr. Szivek said.

To test this theory, the 3-D implants will be embedded with tiny sensors that can wirelessly transmit exercise activity. These sensors will analyze loading, or how much weight is being put on the scaffold, and for what length of time.

Bone size changes in an active group that regularly exercises will be compared with an inactive group. Dr. Szivek's team expects to see that the active group that regularly put weight on their healing limbs will show much quicker bone growth. His team hopes to develop guidelines for post-surgical physical therapy by demonstrating that exercise leads to better bone formation.

If the study is successful, Dr. Szivek anticipates the clinical trials will take place in military personnel.

Current treatment of these traumatic injuries usually fails and requires repeated surgeries.

"Patients often re-break the damaged bone area after surgeons try to repair it and the limb will eventually be amputated," Dr. Szivek explained. "There's just no good way of regenerating or re-growing long bone segments right now."

The human body will attempt to re-grow missing or damaged bone for a few months after an injury, but it eventually gives up on the process. At that point, scar tissue fills the defect instead of bone.

"That's why we need to develop a way to grow bone as quickly as possible—to help the body while it is still able to grow and replace the bone," Dr. Szivek said.

UA President Robert C. Robbins, M.D., commended Dr. Szivek's lab.

"This is an incredible example of the kind of innovative research that is made by possible by technological advancement through the convergence of the biological, physical and digital worlds, and exactly the kind of project that demonstrates how the UA is a leader in cutting-edge solutions to difficult challenges," Dr. Robbins said. "The work that Dr. Szivek and his team are doing to help these individuals is a great example of using new technology to significantly improve quality of life for patients. I am confident their unique research will lead to the development of more effective treatments to repair critical bone injuries."

Dr. Szivek hopes the potential therapy also will help patients with bone cancers that are removed operatively.

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