New method of resurfacing bone improves odds of successful grafts

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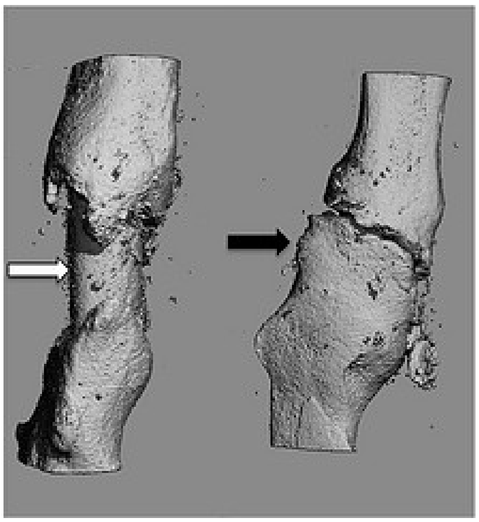

Bone graft coated with inorganic material. Credit: Henry Donahue

(Medical Xpress)—Coating a bone graft with an inorganic compound found in bones and teeth may significantly increase the likelihood of a successful implant, according to Penn State researchers.

Natural bone grafts need to be sterilized and processed with chemicals and radiation before implantation into the body to ensure that disease is not transmitted by the graft. Human bones have a rough surface. However, once a graft is sterilized the surface changes and is not optimal for stimulating bone formation in the body.

"We created a method for resurfacing bone that had been processed, and resurfacing that bone so that it is now nearly as osteogenic as unprocessed bone—meaning it works nearly as well as bone that hadn't been processed at all," said Henry J. Donahue, Michael and Myrtle Baker Professor of Orthopaedics and Rehabilitation, Penn State College of Medicine. "That's the bottom line."

Donahue, who is also a faculty member of the Huck Institutes of the Life Sciences, and Alayna Loiselle, postdoctoral fellow in orthopaedics and rehabilitation, Penn State College of Medicine, teamed up with Akhlesh Lakhtakia, Charles Godfrey Binder Professor of Engineering Science and Mechanics. They developed a way to create a rough surface on bone grafts that is similar in texture to the surface of an untreated bone. This similarity promotes healing in the bone.

The researchers found that by coating a bone with the inorganic compound hydroxyapatite, using physical vapor deposition, they could closely mimic the rough surface of an untreated bone.

To find the optimum thickness of hydroxyapatite, Donahue and Loiselle sterilized the graft samples in their lab at Penn State Hershey Medical Center. After sterilization, the samples went to the University Park campus, where physical vapor deposition layered different amounts of hydroxyapatite on the grafts. Then the samples were returned to Hershey for Donahue and Loiselle to test.

The researchers saw that the optimum thickness of hydroxyapatite was in the middle of what they tested. If the hydroxyapatite coating was not thick enough—or there was none—the graft implant worked, but did not integrate as well as if there were a few nanometers more layered onto the surface. If the hydroxyapatite was too thick, the graft implant again worked, but did not integrate as well as the researchers had seen was possible.

"I thought we wouldn't need to coat the bone more than a couple of hundred nanometers. As it turns out, it was much less than that," said Lakhtakia.

A hundred nanometers is about the size of a single virus.

Fifteen years ago Lakhtakia started an area called sculptured thin films. He thought these might be used to heal broken bones, but wasn't sure how. He suggested that for two bones to be joined, coating the two opposing faces with sculptured thin film might bring them together. Bone is living tissue, so bone would grow through the sculptured thin film and fuse together and create some sort of adhesive bond.

"When [Dr. Donahue] said he had this particular problem and asked if I could do something about it, I thought about that," said Lakhtakia. "In 15 years or so, my understanding had considerably evolved, and the one thing that I thought was that whatever needs to be done on the bone should not take too much time and should be little in size. If it is little, there is a better chance of integration inside the body—less foreign material inside the human body."

The researchers also believe this method could be used for soft musculoskeletal tissue implants and orthopedic device implants.

Provided by Pennsylvania State University

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