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# Tight Fit

by Jonathan Knight

Patient with artificial hip joint

By anchoring metal to bone more effectively, materials scientists hope to produce an artificial joint that lasts for decades instead of a few years.

Nearly half a million patients receive bone implants each year in the US alone. Most of these implants are artificial hip and knee joints made of titanium alloys and attached with bone cement. As new bone grows around an implant a gap tends to appear, so that eventually the implant works loose. As a result, the useful life of an implant may be less than ten years.

In the past, orthopaedic specialists have tried to make titanium joints look more like real bone by coating them with hydroxyapatite, the hard, white form of calcium phosphate that gives normal bone its strength. But while such coatings blend well with bone, they remain poorly attached to the implant. "What you are trying to solve is an attachment problem," says Richard Friedman, an orthopaedic surgeon at the Medical University of South Carolina in Charleston.

Now Allison Campbell, a materials scientist at the Pacific Northwest National Laboratory in Richland, Washington, thinks she may have solved the problem. Before applying the hydroxyapatite, she prepares the metal by linking a long-chain carbon molecule to the titanium atoms via a bridge of silicon and oxygen. "The carbon chains stand up from the surface, kind of like trees," she says. She then immerses the metal in a solution of carboxylic or sulphonic acid, molecules that serve as attachment points for the hydroxyapatite. The final soaking is a solution of calcium and phosphate, the components of hydroxyapatite.

Campbell and her colleagues place coated titanium in contact with bone cells in a culture dish. Bone grows by a process called remodelling, in which cells called osteoclasts break down old bone, while others called osteoblasts secrete collagen and hydroxyapatite to make new bone. Campbell says the bone cells began remodelling the hydroxyapatite coating around the metal, replacing it with fresh bone. "The bone cell thinks it's just more bone right next to it," she says.

The relatively mild conditions of the anchoring procedure make it possible to add growth factors to the mix. Campbell is now testing TGF-beta, a peptide that stimulates cell division. She told a regional meeting of the American Chemical Society in Pasco, Washington, that she hopes growth factors will accelerate the remodelling of bone over implants.

Campbell has asked Friedman to help test the coated implants in real bone. Friedman has installed titanium plugs, either coated or uncoated, into the femurs of anaesthetised rabbits, and let the implants take for several weeks. Next month Friedman will examine the implants for signs that bone has remodelled around them. If the bony coating results in a tighter fit, the technique could be tried with human implants within a year.

"If this method can be shown to create a strong enough bond, it would be a desirable improvement," says **Jacob Rozbruch MD**, an implant specialist in New York City.