Stories of Hope: Bone Repair

It was just a little stumble. Or that's what it seemed to **Diana Souza** when she fell while doing chores on her Northern California ranch. But her left arm was fragile and it snapped where an earlier break had healed crookedly. What came next was worse: three surgeries that didn't work, an orthopedic surgeon proposing a fourth, and an arm bone riddled with holes.

That's when she was introduced to Dr. Mark Lee at UC Davis. He looked at the X-rays of the misshapen bones of her arm and won her confidence. " I can fix this for you," he told her.

Lee had been using stem cells from a patient's bone marrow – called mesenchymal stem cells – to create new bone. Without this treatment, repair options for the most severe fractures leave bones weak and often not functional.
A few weeks later, Souza was in surgery. Lee extracted marrow from the iliac crest of her hips and spun the material in a centrifuge to concentrate the stem cells. Aligning her misaligned bones, Lee introduced stem cells into the gaps.

When Souza saw x-rays of her healed bones several months later, she was astonished. "I was bouncing off the walls. I told Dr. Lee, 'Where's the Swiss cheese! Look how good this has healed!"

"I like my lifestyle and I like what I do," she said. "For me, this was a miracle."

- Watch the Spotlight on bone repair talks

Toward a Cure: bone fracture

Imagine the framework of a house that actually directs its own remodel.

That's the role bone plays in orchestrating it's own repair. The framework of the bone, called the extracellular matrix, initiates the development of blood vessels, instructs stem cells within the bone to multiply, and then guides them to develop into the various types of bone cells.

Knowing the role that extracellular matrix plays in growing new bone, Kent Leach, a biomedical engineer at UC Davis, is hoping that by manipulating the matrix he can improve bone healing or, in some diseases of excessive bone growth, slow it down.

The idea of using the body's own superstructure to grow new bone builds on work Leach has been doing using synthetic materials. Leach's lab uses a porous composite material of bio-ceramic and polymer that acts much like the bone's own framework. The material can push stem cells down the path to bone formation. But it has big limitations. "Surgeons can't shape and mold as they would want for irregular-size defects," Leach says.

The ideal material would direct the formation of new bone, like Leach's solid composite, but also be easy to mold into the right shape.

That's the idea behind a jello-like substance that researchers at UC Davis have so far used to repair bone cysts in horses. It's made out of tiny beads coated with the same type of matrix that is capable of directing bone regrowth. These beads are then suspended in a gel with stem cells. In one study, the researchers injected this gel into bone cysts in horses, which healed in as little as six months—much faster than normal.

But the real appeal of using this kind of matrix is its potential for precise control of the developing bone. A matrix capable of halting bone growth, for instance, holds promise for a condition in infants called craniostenosis in which bones in the skull fuse prematurely, trapping the developing brain in a tiny space. Without room to expand — a child's brain triples in size during the first three years of life — developmental problems may follow.

"The only available treatment is to remove large pieces of bone from the skull, and then overlay the remaining pieces back in and hope that premature bone formation doesn't occur," Leach says. "As engineers and bioengineers, we're thinking about strategies to address these significant challenges."
