Stem Cells from Fat May Help Heal Bone in Wounded Soldiers

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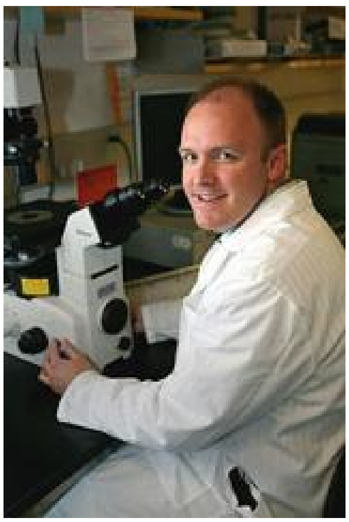

Biomedical engineering professor Kent Leach.

(PhysOrg.com) -- Soldiers in combat suffer massive wounds to bone and tissue quite unlike most injuries that civilian doctors treat. Explosive blasts, rarely encountered in civilian life, cause about 2/3 of the injuries in Iraq. Musculoskeletal injuries account for about 70% of war wounds, and 55% of those are wounds to the arms and legs. Fractures account for 26% of combat injuries.

Thanks to advances in medical care and body and vehicle armor, 90% of these wounded soldiers survive. Their severe injuries, however, may require numerous surgeries for reconstruction. Strategies to improve and speed bone healing could reduce the number of orthopaedic surgeries required and improve patient outcomes for a large percentage of all wounded soldiers.

UC Davis biomedical engineer Kent Leach has received a CDMRP Hypothesis Development Award from the U.S. Army to explore a new approach to tissue regeneration that may speed bone healing and return to function. The results of the study will help develop an effective treatment for wounded soldiers or veterans struggling with slow- or non-healing bone defects.

Dr. Leach will use stem cells derived from human adipose tissue (fat) to stimulate the formation of microvascular networks (neovascularization) within developing bone. Bone regeneration depends upon the formation of these networks to deliver oxygen and other nutrients necessary for healing. Most current clinical approaches inject pure stem cells systemically or locally, yet bone formation is hit or miss.

Dr. Leach's project will embed the stem cells in a special gel to implant them directly in the injured site. This "composite hydrogel" contains a mixture of different polymers that controls the rate at which the gel degrades. Materials that degrade too slowly impede tissue formation, while gels that degrade too quickly will not hold stem cells in place. Scientists mix stem cells and other chemicals into the gel, and inject it, in liquid form, into the bone fracture or defect. The gel congeals, entrapping stem cells at the defect site to promote bone repair. Leach's team has already developed a composite hydrogel and used it to deliver stem cells derived from bone marrow to injured horses.

This approach has two advantages over current approaches. First, stem cells from the patient's own body have a better chance of succeeding than donor cells. The process of extracting bone marrow to obtain stem cells is excruciatingly painful, requires several days of recovery time, and is not feasible for severely injured or weakened patients. Doctors can obtain stem cells from fat with minimal invasiveness.

"Stem cells from adipose tissue are an exciting alternative to stem cells from bone marrow or other tissues because we can isolate a large number, no matter what the patient's condition is," explains Dr. Leach. "With other stem cells, the patient's age, general health, and degree of injury or presence of infection all influence the number of recoverable stem cells and their ability to form bone. This is not true for stem cells from fat."

Second, by using a composite hydrogel to affix the stem cells to the injured bone, Leach's method will increase the amount of stem cells that remain at the damaged site. More stem cells should lead to increased neovascularization and faster bone regeneration. In addition to mixing stem cells into the hydrogel, the team will mix chemicals that attract bone-building substances already present in the patient's tissues. Those substances will stimulate the growth of blood vessels and enable the stem cells to become bone cells.

"This is really exciting, because we don't have to deliver drugs. We're drawing native tissue repair elements directly to the bone defect," says Leach. He envisions a scenario where surgeons in the operating room extract fat, process it in a machine that separates out the stem cells, mix the cells into the composite hydrogel, and then inject the mixture directly into a fracture.

Leach's team will test several compositions in rats to find one that yields the most rapid invasion of new vasculature and resulting bone formation by assessing tissue using noninvasive imaging technologies. The composite hydrogel stem cell therapy for bone healing has not yet been tested in humans.

Provided by UC Davis