Cord Blood Stem Cells: A Promising Future in Orthopedics

The National Institutes of Health (NIH) announced its highly anticipated plan this month to implement President Bush's Executive Order to strengthen the nation's commitment to research non-embryonic, pluripotent stem cells. Pluripotency is the ability of a specific type of stem cell to develop into various cell types and tissues in the body. The NIH strategy to advance this area of research reinforces the medical value of non-controversial sources of pluripotent stem cells — such as those found in cord blood — and the tremendous potential they are showing in research to meet unmet medical needs.

One area where exciting advancements are being seen with pluripotent stem cells is in the fields of orthopedics and sports medicine, where researchers are examining regenerative therapies for previously untreatable conditions, or to improve an existing standard of care.

Prevalence of Orthopedic Conditions and Injuries

Cartilage injuries and defects are notoriously difficult to treat because cartilage is a slow-healing tissue that is unable to repair itself. As a result, cartilage damage can lead to osteoarthritis, a type of arthritis that is caused by the breakdown and eventual loss of cartilage in the joints.[1] Osteoarthritis affects more than 20 million Americans[2] and is the number one cause of disability,[3] accounting for most of the hip and knee replacement surgeries performed in the U.S.[4]

Some of the best candidates for regenerative stem cell therapies may be professional and amateur athletes, as repetitive use of muscles and joints often leads to injury. Each year, more than one million people in the U.S. suffer from injured cartilage, ligaments, tendons and/or bone fractures.

Why Cord Blood Stem Cells May Be the Answer

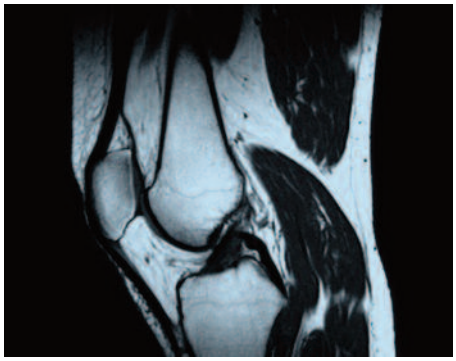
Umbilical cord blood is a source of non-controversial, "embryonic-like" stem cells which are collected at the time of birth in a simple, safe and painless procedure and are preserved for future use.

Because cord blood contains a form of pluripotent stem cells called mesenchymal stem cells, which can differentiate into a variety of cell types including cartilage, bone and fat tissue, it is believed they can be used for the same applications as bone marrow. Cord blood also offers several advantages: collection is less invasive, cord blood stem cells expand more rapidly, and they can differentiate into multiple cell types more easily since they are "younger" than bone marrow stem cells.

These characteristics are especially important for cartilage repair, as one of the key issues researchers face is having a readily available source of stem cells that are highly proliferative and still in their most "immature" state. Because bone marrow is difficult to collect and maintain, and because it's not yet fully known how effective embryonic stem cells may be in this application, it is likely that researchers will look to cord blood stem cells in order to take advantage of these characteristics and to see how they compare to other cell types.

Treating Osteoarthritis

Traditional osteoarthritis therapies address pain and inflammation, but currently there is no standard treatment to slow cartilage degeneration or to repair damaged cartilage in osteoarthritis.[6] Stem cells are now being evaluated as a possible therapeutic option, and below are two clinical examples of successful stem cell therapies used for cartilage repair. While these studies used



More than 200,000 Americans undergo tendon or ligament repair each year, with the most common injury being to the knee's anterior cruciate ligament (ACL), which often occurs during sports.[5]

Cord blood stem cells have nearly infinite medical potential. These stem cells are easily and painlessly acquired from a child's umbilical cord at birth and are not subject to the complex ethical issues that have brought embryonic stem cell research to a standstill. Cord blood stem cells are supported by a wealth of scientific research supported by clinical evidence, with widely recognized safety and efficacy.

bone marrow stem cells,[7] scientific evidence suggests that cord blood stem cells would be a viable alternative since *in vitro* they demonstrate similar capabilities as bone marrow:

In a 2007 report published in the journal *OsteoArthritis and Cartilage,* a 31-year-old athlete with a cartilage defect was treated with autologous (one's own) bone marrow stromal cells.

- Bone marrow cells were harvested, embedded in a collagen gel, and surgically transferred to the cartilage defect

- Seven months post-surgery, the defect was covered with smooth tissue
- One year post-surgery, symptoms had improved significantly and the patient achieved his previous activity levels without complications

In 2004, *Cell Transplantation* also published a report of autologous stem cell treatment for two patients with cartilage defects.[8]

- Bone marrow was collected and embedded in a collagen gel and surgically transplanted into the cartilage defect
- Six months after surgery, symptoms improved and the defect was covered with periosteum – a dense membrane composed of fibrous connective tissue that closely wraps all bone
- The improvement has endured – four years follow-up in one patient and more than five years follow-up in the second

Sports Medicine Applications: Joint, Ligament, Tendon, Muscle and Bone Repair

Research exploring the use of stem cells for tissue rehabilitation is underway, and these therapies may one day be used to help athletes repair potentially career-ending injuries or recover more quickly from common sports conditions like stress fractures, muscle strains and ligament tears. In one such study, mice with fractured femurs experienced noticeable bone healing after receiving injections of human cord blood stem cells to the injury site. Stem cells derived from human and animal fat tissue were first studied at the University of Pittsburgh in the late 1990s. This research resulted in stem cell applications to treat orthopedic injuries in horses, and continues to show great promise. During the past three years, more than 2,000 horses with joint, ligament and tendon injuries have shown full or partial recovery following injections of autologous fat stem cells to the injury site.

In a separate study, researchers are working to perfect the technique of isolating, expanding and differentiating equine cord blood stem cells from newborn fo als. They have succeeded in developing the cord blood stem cells into cell types which are the building blocks of cartilage in order to repair joint injuries.[9]

The success of these therapies provides a model for clinical use in humans, as horse joints are similar to human joints in aspects such as thickness and susceptibility to spontaneous athletic injury.[10]

Research in Humans

Leading stem cell experts and orthopedists agree that human clinical trials for orthopedic regenerative stem cell therapies may be underway in the next three to five years. These advancements could transform orthopedic medicine, as stem cells provide significant advantages over traditional surgeries to repair injuries: stem cell infusions are minimally invasive; use biological rather than synthetic materials for treatment; and provide long-term solutions by actually regenerating damaged tissue.

For use in regenerative therapies, scientific evidence suggests that autologous stem cells deliver the best outcomes for patients. Cord blood will likely be evaluated for these and many other indications in the future as more people have access to their preserved, autologous cord blood.

References

1. MedicineNet.com. *Osteoarthritis (Degenerative Arthritis).* Available at: http://www.medicinenet.com/osteoarthritis/article.htm. Accessed 9/4/07. **2.** National Women's Health Resource Center. *Osteoarthritis.* Available at: http://healthwomen.org/healthtopics/osteoarthritis. Accessed 8/9/2007. **3.** American Academy of Orthopedic Surgeons. "Total knee replacement fact sheet." Available at: http://orthoinfo.aaos.org/fact/thr_report.cfm?Thread_ID=513&topcategory=Knee. Accessed 4/18/2007. **4.** National Women's Health Resource Center. *Osteoarthritis.* Available at: http://healthwomen.org/healthtopics/osteoarthritis. Accessed 8/9/2007. **5.** University of Virginia Health System. *Orthopedic Surgery.* Ligament Injuries to the Knee. Available at: http://www.healthsystem.virginia.edu/uvahealth/adult_orthopaedics/ligament.cfm. Accessed 9/7/07. **6.** MedicineNet.com. *Osteoarthritis (Degenerative Arthritis).* Available at: http://www.medicinenet.com/osteoarthritis/article.htm. Accessed 9/4/07. **7.** Kuroda R, Ishida K, Matsumoto T, et al. Treatment of a full-thickness articular cartilage defect in the femoral condyle of an athlete with autologous bone-marrow stroma cells. *OsteoArthritis and Cartilage.* 2007;15:226-231. **8.** Wakitani S, Mitsuoka T, Nakamura N, et al. Autologous bone marrow and stromal cell transplantation for repair of full-thickness articular cartilage defects in human patellae: two case reports. *Cell Transplantation.* 2004;13:595-600. **9.** Perret, Jennifer. "Stem cell therapy targets cartilage defects." Available at: http://www.horsetalk.co.nz/health/112-stemcell.shtml. Accessed 9/6/2007. **10.** Vet-Stem Regenerative Veterinary Medicine. "Equine Applications." Available at: http://www.vet-stem.com/equine/. Accessed 9/6/2007.