Cord Blood May Help Repair Children's Heart Defects

Stem cells from umbilical cord blood may provide the raw material to repair the hearts of thousands of babies born each year with defective heart valves, according to data presented at last week's American Heart Association annual meeting.

Cardiologists from the University Hospital of Munich report they are about five years away from transplanting new heart valves into children with heart defects, made from the children's own cord blood.[1]

Congenital heart defects - or problems with the heart's structure that are present at birth - are the most common type of major birth defect.[2] In children with heart valve abnormalities, the valves do not fully open or close and impede the flow of blood.[3] While surgeons can transplant new valves from donors or from artificial material, these valves won't grow as the children do, meaning these individuals will require repeated operations to provide them with new, larger valves, said Dr. Ralf Sodian, the cardiac surgeon who led the research.[1]

Replacement heart valves made from the child's own cord blood stem cells would theoretically grow with the child and change shape as needed, significantly reducing the number of surgeries necessary for these patients.

In this study, the cord blood stem cells were seeded onto biodegradable heart valve scaffolds and grown in the laboratory. The cells formed a tissue layer around the scaffolding and further tests showed the engineered cells formed viable heart tissue. When their ability to handle blood flow and pressure were tested, the valves created from cord blood stem cells showed capabilities similar to natural heart valves.[4]

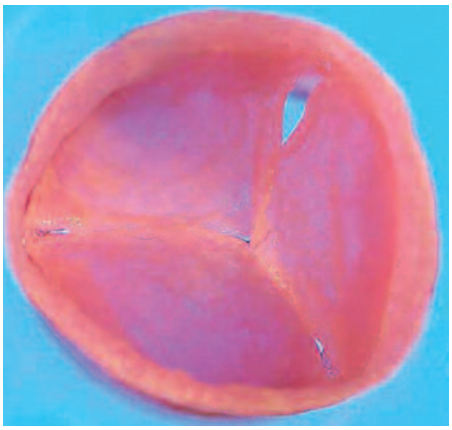
Similar results from a pre-clinical study showed cord blood endothelial stem cells demonstrated excellent growth potential for tissue-engineered vascular grafts that could replace human heart defects.[5]

The research presented this week - as well as those pre-clinical findings - offer a compelling reason why parents with a child diagnosed intrauterinely with congenital defects should consider preserving their child's cord blood, since it may offer a treatment option in the future.

About Cardiovascular Disease

Cardiovascular disease is the leading cause of death for both men and women in the U.S. Approximately one million people die of cardiovascular disease annually despite medical intervention, with coronary artery disease claiming 50 percent of those lives.[6] Although heart disease impacts an older population whose heart muscle, arteries and pumping function have deteriorated over time, heart ailments also strike the very young. According to the National Institutes of Health, congenital heart disease is responsible for more deaths in the first year of life than any other birth defect.[7]

To date, there is no proven "off-the-shelf" therapy to repair or regenerate the heart after acute myocardial infarction (heart attack) or congestive heart failure. Because heart cells have a limited capacity to regenerate, researchers are exploring potential therapies using various stem cell sources to repair or replace damaged tissue including vascular endothelial cells, which form the inner lining of new blood vessels, and cardiomyocytes, the heart muscle cells that contract to pump blood into and out of the heart.[8]



"Tissue-engineered heart valve generated from human marrow stromal cells from a separate pre-clinical study. (Hoerstrup et al.)"

About Cardiovascular Disease and Cord Blood

The stem cells found in a newborn's umbilical cord blood are one type of stem cell holding great promise in cardiovascular repair.

Stem cells from cord blood may have an advantage over those found in bone marrow or peripheral blood because they are immunologically "younger" and appear to be more versatile. They also demonstrate an important characteristic with embryonic stem cells: they are able to differentiate into nearly all cell types in the body. However, cord blood stem cells offer important advantages: 1) they do this in a safe and controlled manner; 2) they have been used in clinical practice to treat humans for more than 20 years; and 3) there is no controversy involved in their collection.

Researchers are noting several positive observations in pre-clinical animal studies. Thus far, in animal models, cord blood stem cells have shown the ability to selectively migrate to injured cardiac tissue, improve vascular function and blood flow at the site of injury, and improve overall heart function.[6]

Repairing Blood Vessels and Improving Ventricular Function

The heart demands a large volume of blood flow in order to bring nutrients and oxygen to the muscle tissue after it has been damaged. Research demonstrates that cord blood stem cells are capable of giving rise to vascular endothelial-like cells, which are believed to aid in the repair of heart tissue damage due to myocardial infarction.

Several pre-clinical studies of induced myocardial infarction in rats have shown that cord blood stem cells have the ability to:

- Migrate and engraft to damaged heart muscle[9,10]
- Contribute to the formation and proliferation of new blood vessels[9,11]
- Improve left ventricular remodeling, structural damage and function[12]
- Decrease the size of infarction[13]

These animal studies may lay the foundation for future human clinical trials testing cord blood stem cell treatment for patients with heart damage due to myocardial infarction.

Cardiomyocytes and Cord Blood: In Vitro Studies Show Promise

Permanent loss of cardiomyocytes (heart muscle cells) and the formation of scar tissue following a heart attack result in irreversible damage to cardiac function. Human cord blood contains several different types of stem cells including hematopoietic, endothelial and mesenchymal stem cells. Although still in early stages, four in vitro studies have shown that under certain treatment conditions, cord blood mesenchymal stem cells differentiate into cardiomyocyte-like cells[14-17] and were able to induce regeneration of healthy cells from damaged cardiomyocytes.[17] This suggests that cord blood stem cells have a high potential to differentiate into cardiomyocytes and aid the regeneration of cardiomyocytes lost due to heart damage.

Advances in Peripheral Vascular Disease

The ability of cord blood stem cells to become vascular endothelial-like cells and thus, blood vessels, indicates they will likely have potential applications beyond the heart.

Peripheral vascular disease (PVD) is a restriction of blood flow outside of the heart usually occurring in the legs and arms. Restricted blood flow is caused by blood vessel narrowing from fatty plaque formation on vessel walls (atherosclerosis) or blockage due to blood clots. If the blockage is severe enough, tissue death can occur. If left untreated, the limb may need to be amputated.[18]

In animal models, cord blood stem cells have been able to significantly reverse the effects of ischemia, or loss of blood flow in the blood vessels. In models of hind limb ischemia, transplantation of cord blood stem cells appeared to reverse surgery-induced ischemia resulting in limb salvage.[19,20] These observations may lead to future human clinical trials using cord blood stem cells to treat patients with peripheral vascular disease.

The Future of Cord Blood Stem Cell Cardiac Therapy

As a next step to the research presented at the American Heart Association meeting, the study investigators plan to begin experiments next year to test their procedure in animal models. They will implant the heart valves made from cord blood into the hearts of young lambs, observing their ability to grow and function over time.[1]

The growing library of research on cardiac repair suggests an infant's own cord blood could prove to be a valuable treatment option not just for treating a congenital heart defect, but perhaps later in life if the individual experiences a sudden and serious heart attack.

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