Research gives new hope for restoring cells in damaged brains and spinal cords

20 January 2015, by Barbara K. Kennedy

An artist's rendition of a human spinal cord. Credit: EMSL Creative Commons license

What motivates Penn State scientists and their students to devote countless hours trying to solve tough research mysteries? For Gong Chen, a biology professor at Penn State, the answer is rooted in a desire to help relieve the suffering of patients and their loved ones.

"I want to help people who are suffering from injuries and diseases of the brain and spinal cord," he told a crowd of Alzheimer's patients and their friends and family at Medlar Field at Lubrano Park.

During the Alzheimer's Association's Walk to End Alzheimer's Disease in October, the crowd broke into applause, cheers and some tears when Chen announced his lab's most recent research achievement.

"We have developed a revolutionary approach for reversing scarred tissues inside the brain back into normal neural tissue," he said.

Chen, who is Penn State's Verne M. Willaman Chair in the Life Sciences, directs a research team that is working on simultaneous research projects related to brain and spinal-cord disorders. These disorders include Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis, stroke, traumatic brain injury, spinal-cord injury, epilepsy, autism and schizophrenia.

The lab's technique for repairing scarred tissues in the brain is the latest in a recent series of discoveries that have been published by highly respected scientific journals including *Cell*, *Nature*, *Cell Stem Cell* and *Nature Communications*, among others.

The brain has neuronal cells, called neurons, and another kind called glial cells. When glial cells are healthy, they are important components of the brain's nervous system. Healthy glial cells surround neurons—the brain's nerve cells—and provide them with support, protection, insulation, oxygen and nutrients. But when neural tissue is damaged by strokes or trauma, the glial cells will react by multiplying—sometimes so excessively that they clog up the nervous system and form a glial scar, causing even more health problems for patients.

For example, glial scars that form after an injury to the spinal cord can create a blockage in the spinal cord, which may shut down the communication channel between the brain and muscles that control the legs, leaving the person unable to walk.

Recent research, published in *Cell Stem Cell*, describes the successful tests of Chen's lab's new technique in behavioral tests with a strain of laboratory mice known to have memory deficits and brain-cell abnormalities similar to those of human patients with Alzheimer's disease. The research demonstrated that, even in very old mice with Alzheimer's disease, Chen's team was able to regenerate many functional neurons from the internal glial cells of these mice and to replenish the lost neurons in the brains of the mice. This research raises the hope that neural-replacement therapy might someday help human patients.

Chen's lab has taken another big step by proving, as well, that human glial cells can be changed directly into neuronal cells—although this research with human brain cells can only be done in petri dishes in the lab at this time.

"Currently, there is no method available, other than the one we have developed, to repair brains by reversing glial scars back to normal neural tissues," Chen said.

The research is important because it suggests a whole new research approach for developing a novel and effective therapy for Alzheimer's disease.

"Many other research teams are injecting stem cells that are not the same as a patient's own cells into the brain to make new neurons there, but they are facing rejection by the immune system and other setbacks," Chen said. "Our technology is different. Because our method is changing the brain's own glial cells into neuronal cells, it does not require transplantation."

Chen's lab now is working on developing techniques for both gene therapy and drug therapy with the goal of moving the research through all the stages of human clinical trials that will be necessary before the therapies can be used to treat patients.

"Gene therapy will require brain surgery, but the treatments can be delivered directly into the brain. Drug therapy uses chemically-synthesized compounds and potentially can be developed into drug pills," Chen said. "It is exciting to imagine that, someday, patients may be able to take drug tablets every morning to regenerate new neurons in their brains."

Chen said he hopes that his lab's new technology eventually can be used to help patients with a range of neural injuries and diseases involving scarring of glial cells.

"This area of our research is focused on discovering effective treatments for brain disorders including Alzheimer's disease, Parkinson's disease and ALS—which involve the degeneration of neurons; stroke—which involves neuron injuries caused by events inside the brain; traumatic brain injury and spinal-cord injuries—which involve neuron damage caused by traumas from external forces like accidents and violence; and epilepsy, which can be caused by many factors," he said.

In addition to these kinds of disorders, Chen's lab also has research projects focused on autism and schizophrenia, which are neuropsychiatric disorders.

"We are working hard to move our research from the lab bench to the bedside as quickly as possible in order to directly help patients suffering from a wide range of brain and spinal-cord conditions," Chen said. "I want to let people know that our current research results can give them good reasons to hope."

Provided by Pennsylvania State University