Nano World: Nanofibers for brain repair

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Self-assembling biodegradable scaffolds made of fibers only nanometers or billionths of a meter wide helped repair brain damage and return vision in surgically blinded hamsters, experts told UPI's Nano World.

"This appears to be the first time that nanotechnology has been used to repair the brain," said researcher Rutledge Ellis-Behnke, a neuroscientist at both the Massachusetts Institute of Technology in Cambridge and the University of Hong Kong Medical Faculty.

In the future, such research could help patients of strokes or traumatic brain injuries.

"There are 550,000 new cases of severe stroke a year, with over 3 million living with the effects of severe stroke today in the United States alone. There are about 100,000 new cases of severe traumatic brain injury a year, with 2 million living with the effects," Ellis-Behnke said. "Those are the reasons I do what I do every day."

The fibers are made of peptides, the same construction blocks proteins are made from. These peptides assemble themselves into fibers roughly 10 nanometers in diameter when in the presence of the kinds of salt levels normally found in the body. This way, the scientists can set up scaffolds inside the body that help guide cellular re-growth without having to cut patients open to implant such a device.

In experiments, the scientists cut a nerve tract within the brain's visual system in young and adult hamsters, resulting in blindness. The researchers then injected the peptides, which formed interwoven networks of fibers similar to those in the extracellular space that normally holds tissues together. The peptide fibers helped bridge severed brain tissue and created a permissive environment for neural pathways to grow through.

"Within the first 24 hours, the tissue starts to heal itself, even without the use of growth factors," Ellis-Behnke said.

The neural pathways grew through the gap, eventually helping the surgically blinded hamsters regain enough vision to turn toward nearby sunflower seeds far more often than blind hamsters did. The nanofibers broke down into non-toxic compounds that were excreted in the urine after about three to four weeks or possibly used by the brain for growth and repair. Ellis-Behnke stressed their experiments only helped restore vision in this specific case of surgically inflicted blindness.

Intriguingly, the scaffolds apparently helped prevent the formation of the scar tissue often seen in brain damage. Ellis-Behnke speculates the nanofibers may have kept the toxic compounds that are often released during brain injuries from propagating, which may thus have prevented scar formation. The nanofibers may also have kept neurons alive after injury, aiding in proper nerve re-growth.

Neurobiologist Tat Fong Ng at the Schepens Eye Research Institute in Boston noted the severed ends of the nerves in these experiments lay relatively close together. "It will be very interesting if they can show regeneration over a long distance," he said. "You could think about spinal-cord injuries."

The researchers are incorporating growth factors into their peptides to achieve even better results. In addition, they are planning experiments to see how effective their nanofibers are on injuries where the severed ends of wounds are farther apart and on injuries where scar tissue may have formed.

Ellis-Behnke hopes to have the nanofibers in human trials in three to five years, perhaps at first to mitigate the inadvertent damage unavoidably caused during brain surgery.

"There is so much activity going on in the space of neurological surgery," said Steve Kelly, a serial entrepreneur at the Massachusetts Institute of Technology's Deshpande Center for Technological

Innovation. "If you look forward to the next 10 to 15 years, neuroscience, neurosurgery, implants and implantable controls that return function to stroke and paralyzed patients are all really up and coming areas. To have a material that could facilitate healing from neurosurgery, that's really exciting."

Ellis-Behnke and his colleagues report their findings online this week via the Proceedings of the National Academy of Sciences.