Researchers use nanoparticles to deliver treatment for brain, spinal cord injuries

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Purdue University researchers have developed a method of using nanoparticles to deliver treatments to injured brain and spinal cord cells. A team led by Richard Borgens of the School of Veterinary Medicine's Center for Paralysis Research and Welden School of Biomedical Engineering coated silica nanoparticles with a polymer to target and repair injured guinea pig spinal cords. That research is being published in the October edition of the journal *Small.*

The team then used the coated nanoparticles to deliver both the polymer and hydralazine to cells with secondary damage from a naturally produced toxin. That research was published in August by the journal *Nanomedicine.*

Borgens' group had previously shown benefits of the polymer polyethylene glycol, or PEG, to treat rats with brain injuries and dogs with spinal cord injuries. PEG specifically targets damaged cells and seals the injured area, reducing further damage. It also helps restore cell function, Borgens said.

In previous studies, PEG was mixed with saline and injected.

"Composition and concentration limited how much PEG we could get to the injury," he said.

"If you change the composition to make the PEG more potent, it produces ethylene glycol, the poison in antifreeze. If you change the

concentration of PEG in another way, the solution becomes syrupy and difficult to inject."

So the team - which includes Youngnam Cho of the Center for Paralysis Research, Riyi Shi of the center and Weldon School, and Albena Ivanisevic of Weldon School and the Department of Chemistry - turned to silica nanoparticles.

"These particles are so tiny they can't be seen with a regular microscope. They are about the size of a large virus. So you can inject as many as you need. And they are safe inside bodies," Borgens said.

In the first study, the researchers coated the nanoparticles with PEG to treat guinea pig spinal cord injuries. The treated spinal cord cells showed improved physiological functioning.

In the second study, the researchers added both PEG and hydralazine, an antihypertension drug, to mesoporous silica nanoparticles. These nanoparticles have pores that can hold the drug, which is later delivered to the damaged cells. The hydralazine was added to fight off secondary damage to cells that occurs after the initial injury.

"When cells are injured, they produce natural toxins," Borgens said. "Acrolein is the most poisonous of these toxins. It's an industrial hazard for which hydralazine is an antidote."

Borgens and his team introduced acrolein into cells and then treated the cells with different combinations of hydralazine and/or PEG delivered by the mesoporous silica nanoparticles.

They found that the treatment restored disrupted cell function caused by acrolein.

The team concluded that the use of nanoparticles to deliver both PEG and hydralazine increased the effectiveness of earlier PEG-only treatment by controlling and concentrating release of the drug and the polymer, producing a dual treatment and prolonging the treatment's duration.

The goal of Borgens' research is to improve the quality of life of those who have suffered head or spinal cord injuries.

"All ambulances should have PEG on board," he said. "It can probably save thousands of people from more severe head and spinal damage."

Source: Purdue University