

IIT Guwahati succeeds in regenerating damaged nerve

Rats with regenerated sciatic nerve exhibited significantly better walking pattern

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Researchers at the Indian Institute of Technology (IIT) Guwahati have taken the first successful step in treating peripheral nerve damage which can result from traumatic injuries caused by accidents, physical conflict, bullet wounds as well as during surgical intervention. The nerve conduits synthesised by the researchers and implanted in rats with sciatic nerve injury showed "excellent" functional recovery one year after implantation. The results were published in the journal *Bio-medical Materials*.

A team led by Prof. Utpal Bora from the Department of Biosciences and Bioengineering at IIT Guwahati synthesised nerve conduits by electrospinning a mixture of silk fibroin protein and electrically conductive polymer called polyaniline. To produce tubular shaped nerve conduits, the researchers rolled the electrospun sheets multiple times over a stainless steel spindle.

"In tissue engineering, silk fibroin protein is routinely used as a scaffold. Since silk is not electrically conductive we coated it with polyaniline nanoparticles, which is a good electrical conductor," says Dr. Suradip Das from the Department of Biosciences and Bioengineering at IIT Guwahati and the first author of the paper; he is currently at the University of Pennsylvania, U.S.

Nerves are like electrical wires where the conducting portion of the nerves is covered with myelin (a fatty white substance) sheath secreted by specialized cells called Schwann cells that forms an insulating layer. To fabricate a conduit that mimics this native architecture, the Schwann cells, which surround the axons, were cultured on the conduits. The Schwann cells were found to grow between the multiple layers of silk fibroin-polyaniline composite, and also on the



Innervate: "This is a first step to make locally developed nerve implants available in India," says Utpal Bora (right).

■SPECIAL ARRANGEMENT

surface and inside of the conduit.

"The Schwann cells produce myelin sheath which act as biological insulators and play a crucial role in nerve regeneration. Our aim was to seed the conduit with Schwann cells so they initiate the regeneration process when the conduits are implanted in animals," says Dr. Das.

To test how well the nerve conduit synthesised in the lab helped in nerve regeneration, the researchers removed 10 mm of sciatic nerve from rats and implanted the conduit. The surgical area was reopened after six and 12 months.

Compared with untreated animals where the nerve gap was found to have grown further, the conduits in the treated animals showed no deformation or dislocation. The polyaniline was not toxic to rat Schwann cells when 0.1% of polyaniline was used.

Regenerated neurons

"But most importantly, we found regenerated neurons and Schwann cells inside the conduit. And there was myelin sheath over axons in the regenerated tissue from inside

the conduits," he says. "The conduit helped initiating and enhancing the quality of regeneration across the nerve gap."

In terms of functional neuro-regeneration, the conduits seeded with Schwann cells exhibited as high as 86% velocity of current propagation through the nerve. The ability of the nerves to control muscle contraction was also found to be good at 80%.

"Nerves when electrically stimulated contract the muscles. We stimulated one end of the conduit electrically and recorded electrical output from the muscle. If there is a gap along the conduit then the signals won't travel," Dr. Das explains.

Finally, the electrical property of the muscles that are directly innervated was 70%. "If the nerves don't reach the muscles then we won't be able to register muscle electrical activity. If there is good muscle electrical response then it is an indication that the nerve has grown and is able to communicate with the muscles and the muscles are not dead," he says.

Rats with regenerated sciatic

nerve exhibited significantly better walking pattern compared with other groups in the study. "This is proof that our work could restore a lot of the sciatic nerve functions in rats," Dr. Das says.

From rats to pigs

The next step is to conduct trials on pigs, which are genetically and physiologically closer to humans. "We have plans to undertake trials on pigs to collect more animal data," says Prof. Bora. But conducting trials on bigger animals might be a challenge in India. "Conducting research on higher animals is proving to be difficult in India," says Dr. Kushal K. Sarma from the College of Veterinary Science, Khanapara, Guwahati and one of the authors of the paper.

"There is a growing demand for nerve implants with increasing number of road accidents but there are no indigenously developed nerve conduits available in India. We have taken the first step to make locally developed nerve implants available in India," Prof. Bora says.