Medical Xpress

Micro implants could restore standing and walking

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Biomedical engineering researcher Vivian Mushahwar is developing spinal implants that could one day restore the ability to stand and walk in patients with paralysis. Credit: Ross Neitz

When Vivian Mushahwar first applied to grad school, she wrote about her idea to fix paralysis by rewiring the spinal cord.

It was only after she was accepted into a bioengineering program that the young electrical engineer learned her idea had actually prompted laughter.

"I figured, hey I can fix it, it's just wires," Mushahwar said. "Yeah, well, it's not just wires. So I had to learn the biology along the way."

It's taken Mushahwar a lot of work over two decades at the University of Alberta, but the Canada Research Chair in Functional Restoration is still fixated on the dream of helping people walk again. And thanks to an electrical spinal implant pioneered in her laboratory and work in mapping the spinal cord, that dream could become a reality in the next decade.

This is spinal map

Because an injured spinal cord dies back, it's not simply a matter of reconnecting a cable. Three herculean feats are needed. You have to translate brain signals. You have to figure out and control the spinal cord. And you have got to get the two sides talking again.

People tend to think the brain does all the thinking, but Mushahwar says the spinal cord has built-in intelligence. A complex chain of motor and sensory networks regulate everything from breathing to bowels, while the brain stem's contribution is basically "go!" and "faster!" Your spinal cord isn't just moving muscles, it's giving you your natural gait.

Other researchers have tried different avenues to restore movement. By sending electrical impulses into leg muscles, it's possible to get people standing or walking again. But the effect is strictly mechanical and not particularly effective. Mushahwar's research has focused on restoring lower-body function after severe injuries using a tiny spinal implant. Hair-like electrical wires plunge deep into the spinal grey matter, sending electrical signals to trigger the networks that already know how to do the hard work.

In a new paper in *Scientific Reports*, the team showcases a map to identify which parts of the spinal cord trigger the hip, knees, ankles and toes, and the areas that put movements together. The work has shown that the spinal maps have been remarkably consistent across the animal spectrum, but further work is required before moving to human trials.

The implications of moving to a human clinical setting would be massive, but must follow further work that needs to be done in animals. Being able to control standing and walking would improve bone health, improve bowel and bladder function, and reduce pressure ulcers. It could help treat cardiovascular disease—the main cause of death for spinal cord patients—while bolstering mental health and quality of life. For those with less severe spinal injuries, an implant could be therapeutic, removing the need for months of gruelling physical therapy regimes that have limited success.

"We think that intraspinal stimulation itself will get people to start walking longer and longer, and maybe even faster," said Mushahwar. "That in itself becomes their therapy."

Small steps

Progress can move at a remarkable pace, yet it's often maddeningly slow.

"There's been an explosion of knowledge in neuroscience over the last 20 years," Mushahwar said. "We're at the edge of merging the human and the machine."

Given the nature of incremental funding and research, a realistic timeline for this type of progress might be close to a decade.

Mushahwar is the director of the SMART Network, a collaboration of more than 100 U of A scientists and learners who intentionally break disciplinary silos to think of unique ways to tackle neural injuries and diseases. That has meant working with researchers like neuroscientist Kathryn Todd and biochemist Matthew Churchward, both in the psychiatry department, to create three-dimensional cell cultures that simulate the testing of electrodes.

The next steps are fine-tuning the hardware—miniaturizing an implantable stimulator—and securing Health Canada and FDA approvals for clinical trials. Previous research has tackled the problem of translating brain signals and intent into commands to the intraspinal implant; however, the first generation of the intraspinal implants will require a patient to control walking and movement. Future implants could include a connection to the brain.

It's the same goal Mushahwar had decades ago. Except now it's no longer a laughable idea.

"Imagine the future," Mushahwar said. "A person just thinks and commands are transmitted to the spinal cord. People stand up and walk. This is the dream."

More information: Amirali Toossi et al. Functional organization of motor networks in the lumbosacral spinal cord of non-human primates, *Scientific Reports* (2019). DOI: 10.1038/s41598-019-49328-1

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