A giant step for mankind

Neurostep offers the technology to put one foot in front of the other

Charles Schulz once said that no problem is so formidable that you can't walk away from it. But what if walking away is the problem? What if neurological disabilities prevent you from moving?

It's a dilemma that Dr. J. A. Hoffer, professor of kinesiology at Simon Fraser University (SFU), just may have resolved. Hoffer is the creator of Neurostep, a pacemaker-like device implanted in the thigh to enable people with strokes, spinal cord injuries or MS to walk again.

Thirty years ago, Hoffer had a curiosity. He wanted to see what sensory activity flowed during movement. He was fascinated by motor control and how the brain sensed body information, and then integrated it into movement through feedback.

His PhD thesis was to develop a method of recording or sensing signals from nerves (in animals). The key, he thought, to developing a clinical application would start with studying the nerve signals. He hooked up with Prof. W. B. Marks, a biomathematician at Johns Hopkins interested in analyzing the simultaneous activity of neurons.

"I was discouraged by other professors from joining this project," said Hoffer. "They said it won't work. If it would, someone else would have done it by now. It's a poor way to advance science, so I took up the challenge."

He explained that nerves are fragile. They also need to bend and stretch during movements. A huge part of the challenge was to overcome the difficulty of placing something around an individual nerve to record activity, without damaging the nerve.

"It was a combination of choosing an appropriate location in the body where nerves are amenable to placing a device around them, and designing a nerve cuff electrode which surrounds the nerve without harming it, and picks up micro volt-level activity," he said. "It was a mechanical challenge and an electrical challenge. The signals nerves produce are really tiny compared to the millivolt-level electrical noise from surrounding muscles and the heart."

He published research results from this thesis in the early '80s and thought that some day it could form the ideal method to make a permanent connection to the peripheral nervous system. Normally, nerves carry information between the brain and spinal cord and the rest of the body. If a disability stops this communication from working, it's possible to intervene and take over essential brain and spinal cord functions.

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"A device with the capacity to generate walking activity as the brain would have done," explained Hoffer.

In fact, it's an intelligent device that can capture sensory information flowing in the nerve, like when a step starts or ends; vital information if you intend to walk.

"It mimics what the body does," said Hoffer. "It isn't robotic. It replaces the paralyzed parts of the control centre. You still use the limb itself."

When you know the pattern involved in walking, he said, you can program the device to cause the paralyzed muscles to contract. The Neurostep turns the muscles on and off in appropriate ways. With four channels, it offers multi-channel stimulation so the person gets the right combination of muscle activation for the desired movement. In other words, strength and trajectory are again controlled.

The Neurostep has been tested successfully in one pilot patient, a 70-year-old male who suffered a stroke three years earlier. Clinical trials started this spring.

The Neurostep is surgically implanted. The device has a control unit which resembles a pacemaker, located under the skin. Two cables—flexible wires—end in nerve cuffs made of silicone rubber, thin-walled and flexible. The surgeon attaches the nerve cuffs around the nerves: one motor nerve to stimulate the muscles and one sensory nerve to bring information from the sole of the foot.

"In a sense," said Hoffer about the Neurostep, "it pretends to become a part of the brain and spinal cord. The control unit replaces functions that the brain and spinal cord no longer do."

Paralyzed individuals experience muscle atrophy due to disuse, just like astronauts do after a few weeks in space. The Neurostep has an exercise mode where, for the first few weeks after implant, the device exercises the muscles with 10-minute bursts of activity. By restoring strength and resistance to fatigue, said Hoffer, the person will be able to walk again for longer periods of time and with greater balance.

The nerve cuff technology was patented and, in 1997, Hoffer and his team created a SFU spin-off company called Neurostream Technologies. It was bought in 2004, just after the first human implant, by Victhom Human Bionics. Hoffer is on Victhom's clinical advisory board.

Besides the huge benefit of allowing disabled people to walk again, Hoffer said the Neurostep is convenient because it has no external components to attach. The internal, battery-operated device is always ready to use. Plus, he said, it's a smart device.

"If your leg is horizontal, it goes to sleep. It's on as soon as you stand up. There's nothing to do but start walking."

For more information on Neurostep™ and Victhom Human Bionics go to victhom.com or call 1-888-840-5665 .

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