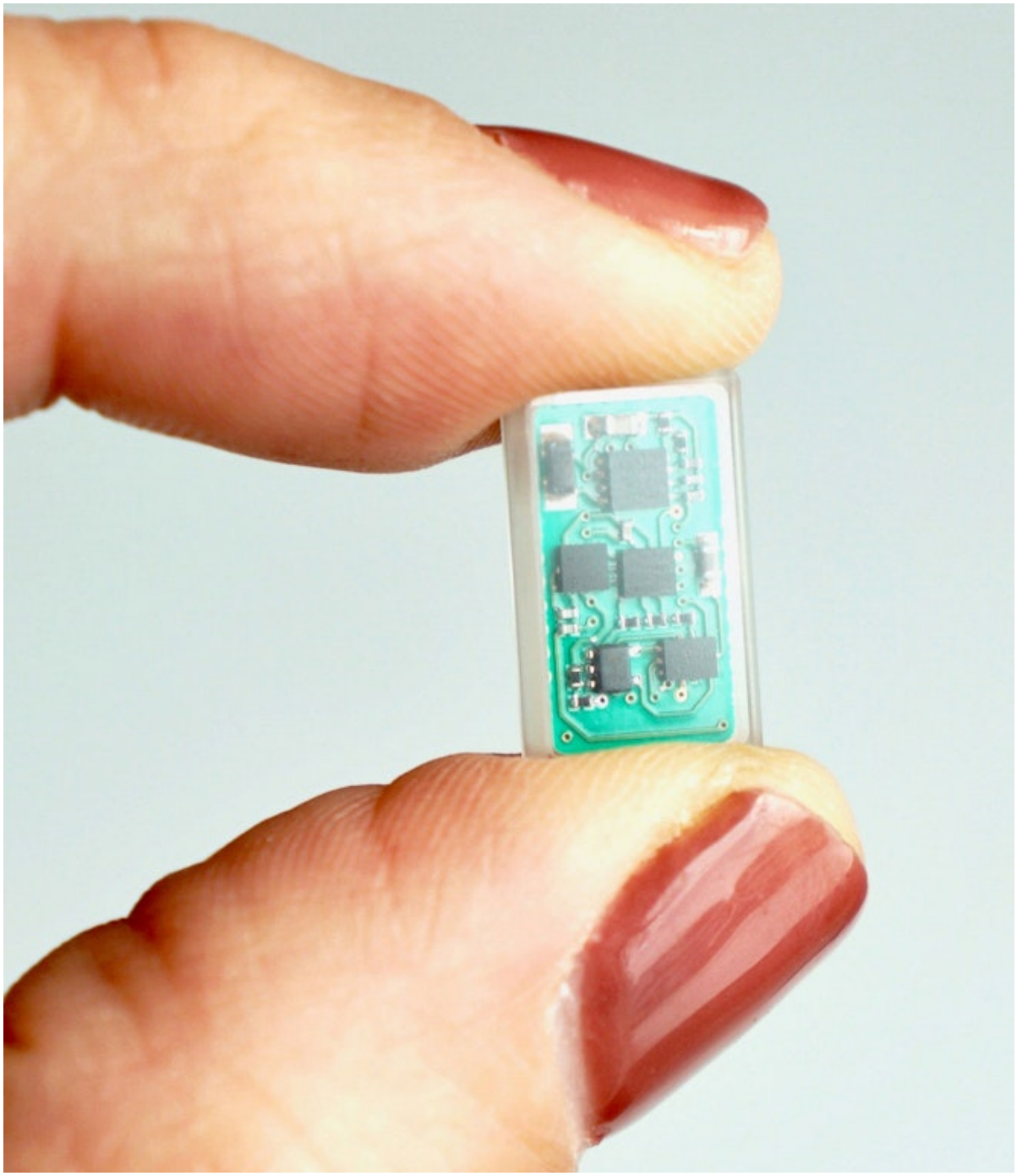
SPINAL CORD INJURIES

Implant can offer hope to survivors

Study: Some with partial impairment regain movement

(From left) Michael Kilgard, Dr. Jane Wigginton, Seth Hays and Robert Rennaker form the leadership group for the Texas Biomedical Device Center at UT Dallas. Kilgard and Rennaker collaborated for about seven years on vagus nerve stimulation for people with incomplete spinal cord injuries. (Photos from University of Texas at Dallas)



UTD's wireless version of the closed-loop vagus nerve stimulation device is about the size of a dime and implanted in the neck.

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People with spinal cord injuries are getting a new lease on life thanks to a tiny neck implant paired with physical therapy.

In a study published last month in the journal *Nature*, researchers at the University of Texas at Dallas showed that pairing a nearly dime-sized vagus nerve stimulator with targeted hand and arm exercises helped people with incomplete spinal cord injuries regain movement — and the ability to do everyday activities like zipping a zipper or latching a necklace — in just 12 weeks.

Vagus nerve stimulation, or VNS, involves electrically stimulating the vagus nerve, the longest of the 12 cranial nerves that runs from the brain to the large intestine. Working much like a pacemaker for the brain, vagus nerve stimulation was first federally approved in 1997 for treating epilepsy and is now being considered for conditions ranging from depression and post-traumatic stress disorder to autoimmune diseases and obesity.

Dr. Sameer Sheth, a professor of neurosurgery at Baylor College of Medicine who was not involved in the study, calls the research a "new avenue" that speaks to "the importance of pairing a disorder-specific therapy — in this case, physical therapy — with some kind of neuromodulatory approach, something that is changing a brain state."

Transformative gains

About 250,000 to 400,000 Americans live with a spinal cord injury, and roughly 18,000 more will develop one, usually from traumatic events such as car crashes, each year, according to the National Institutes of Health.

Most spinal cord injuries occur in young to middle-aged adults, mostly men. The average age at injury was 29 in the 1970s but rose to 43 in the 2010s.

Spinal cord injuries fall into two camps: complete, when the nerve connection is severed, and incomplete, when some signals still sneak through.

Physical therapy can tap into that residual link, yet many people with incomplete spinal cord injuries hit a barrier in their path to recovery.

"Unfortunately, [patients] reach what therapists call their plateau," said Michael Kilgard, a professor of neuroscience at UT Dallas' School of Behavioral and Brain Sciences, who is the study's first author. "They make a lot of progress early on, but then you get to the point where it's just diminishing returns and even no returns."

Kilgard has spent years hunting for ways to shatter that recovery ceiling with vagus nerve stimulation. In early experiments, he and other researchers paired tiny nerve zaps with simple tones and watched the brain rewire itself, doubling or tripling the cells that respond to the sounds.

This phenomenon, known as neuroplasticity, is believed to be driven by growth factors and other chemicals released by the brain during electrical stimulation of the vagus nerve, encouraging new neurons and other cells to flourish.

Kilgard's research eventually led him to collaborate with Robert Rennaker, a bioengineer and associate director of UT Dallas' Texas Biomedical Device Center. Along with other scientists and engineers, the duo worked for about seven years to develop a prototype vagus nerve

stimulation device — wireless and about the size of a dime — that's implanted in the neck during a minimally invasive outpatient procedure that takes only a few hours, said Rennaker.

After the device delivered promising results in animal models of spinal cord injury, the researchers implanted it in 19 Dallas-Fort Worth residents between the ages of 21 and 65 who were at least a year out from their spinal cord injury.

Each volunteer did 18 physical therapy sessions that turned movements such as wrist twisting, hand gripping and finger pinching into game-style exercises that earned new challenges and kept the participants motivated.

Over three weekly sessions, the group of eight getting the vagus nerve stimulation saw a 23% gain in movement, while the control group saw none. After the first round of 18 rehab sessions, all the participants underwent a second round paired with the nerve stimulation. They all saw great gains: on average, a 393% improvement in pinch force and a 152% improvement in wrist torque (a force needed to rotate objects, like turning a door knob).

Future research

Kilgard, Rennaker and their colleagues are now testing to see whether their device can help people with spinal cord injuries who have issues with lower limb mobility. Ultimately, they would like for the device to help those dealing with chronic pain, which affects most people who have had a spinal cord injury.

Kilgard added that learning how to treat chronic pain among people with such injuries could present opportunities for understanding and treating other pain conditions including fibromyalgia, complex regional pain syndrome and postpartum pain.

Sheth of Baylor College of Medicine said it would be interesting to see how vagus nerve stimulation for recovery from spinal cord injury compares to other types of neuromodulation techniques such as deep brain stimulation, where electrodes are implanted directly into specific areas of the brain.

"If VNS can do this, what about actual brain stimulation that's even more targeted to motor systems or to motor learning?" Sheth said. "VNS is less invasive and an easier surgery. It's a matter of how much individuals or society are willing to tolerate in terms of invasiveness for a certain amount of outcome."

For Dr. Jane Wigginton, who has seen a fair share of spinal cord injuries during her career as an emergency medicine physician, the study comes at a time when there are no significant therapeutic advances in spinal cord injury recovery.

"After 25 years at Parkland Hospital, the busiest ER in the whole country, I saw a lot of these people, and they just didn't have any hope for recovery," said Wigginton, co-director of UT Dallas' Clinical and Translational Research Center and co-author of the study. "It's remarkable that we're able to offer them something that's new and gives them hope. That's what really excites me."

Miriam Fauzia is a science reporting fellow at The Dallas Morning News. Her fellowship is supported by the University of Texas at Dallas. The News makes all editorial decisions.