

## Device allows paralyzed man to swipe credit card, perform other movements

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Nick Annetta, right, of Battelle, watches as Ian Burkhart, 24, plays a guitar video game using his paralyzed hand. A computer chip in Burkhart's brain reads his thoughts, decodes them, then sends signals to a sleeve on his arm, that allows him to move his hand. Credit: The Ohio State University Wexner Medical Center

Six years ago, he was paralyzed in a diving accident. Today, he participates in clinical sessions during which he can grasp and swipe a credit card or play a guitar video game with his own fingers and hand. These complex functional movements are driven by his own thoughts and a prototype medical system that are detailed in a study published online today in the journal *Nature*.

The device, called NeuroLife, was invented at Battelle, which teamed with physicians and neuroscientists from The Ohio State University Wexner Medical Center to develop the research approach and perform the clinical study. Ohio State doctors identified the study participant and implanted a tiny computer chip into his brain.

That pioneering participant, Ian Burkhart, is a 24-year-old quadriplegic from Dublin, Ohio, and the first person to use this technology. This electronic neural bypass for [spinal cord injuries](#) reconnects the brain directly to muscles, allowing voluntary and functional control of a paralyzed limb by using his thoughts. The device interprets thoughts and brain signals then bypasses his injured spinal cord and connects directly to a sleeve that stimulates the muscles that control his arm and hand.

"We're showing for the first time that a quadriplegic patient is able to improve his level of motor function and hand movements," said Dr. Ali Rezai, a co-author of the study and a neurosurgeon at Ohio State's Wexner Medical Center.

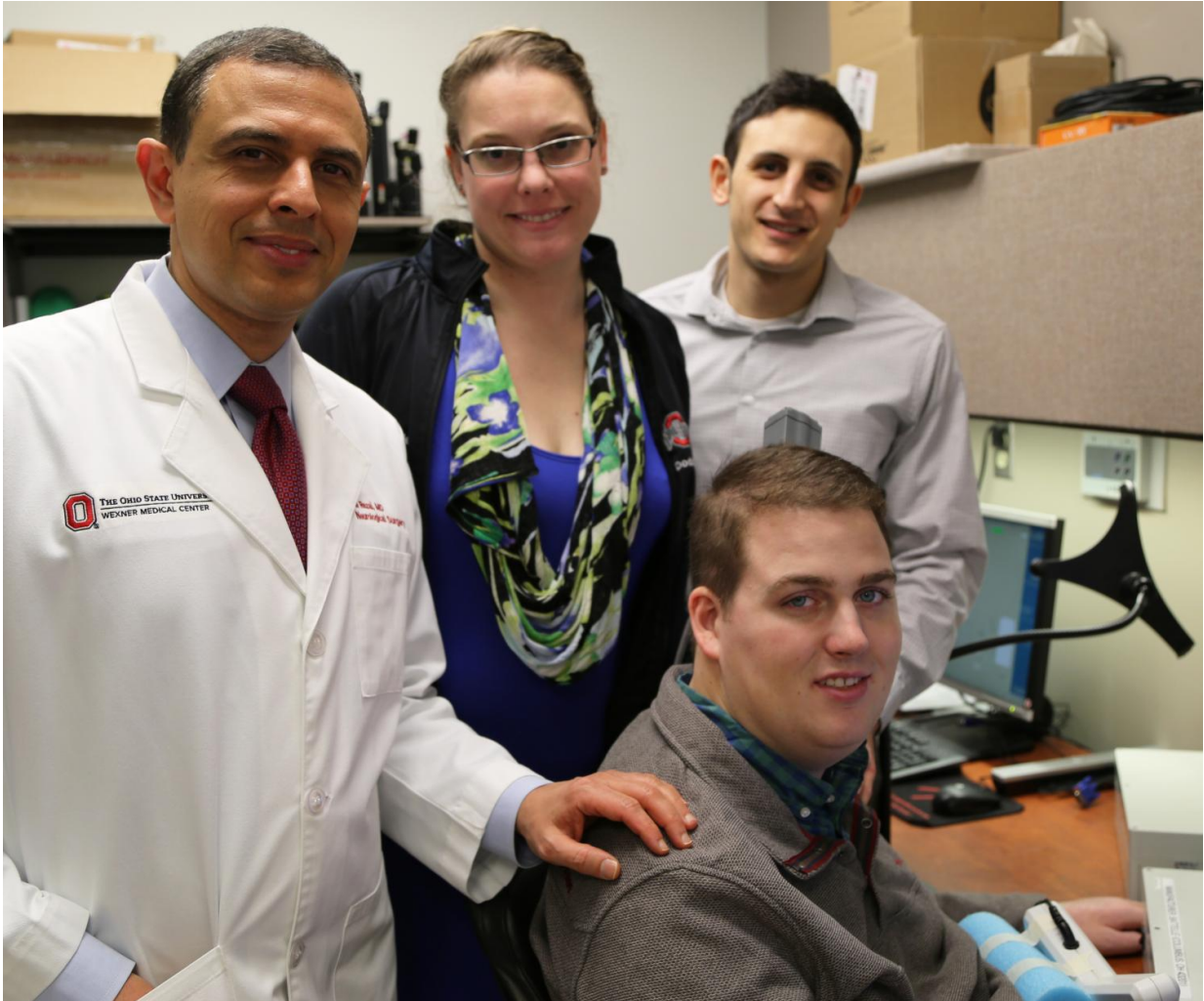
Burkhart first demonstrated the neural bypass technology in June 2014, when he was able to open and close his hand simply by thinking about it. Now, he can perform more sophisticated movements with his hands and fingers such as picking up a spoon or picking up and holding a phone to his ear—things he couldn't do before and which can significantly improve his quality of life.

"It's amazing to see what he's accomplished," said Nick Annetta, electrical engineering lead for Battelle's team on the project. "Ian can grasp a bottle, pour the contents of the bottle into a jar and put the bottle back down. Then he takes a stir bar, grips that and then stirs the contents of the jar that he just poured and puts it back down. He's controlling it every step of the way."

The neural bypass technology combines algorithms that learn and decode the user's brain activity and a high-definition muscle stimulation sleeve that translates neural impulses from the brain and transmits new signals to the paralyzed limb.

The Battelle team has been working on this technology for more than a decade. To develop the algorithms, software and stimulation sleeve, Battelle scientists first recorded neural impulses from an electrode array implanted in a paralyzed person's brain. They used that recorded data to illustrate the device's effect on the patient and prove the concept.

Four years ago, former Battelle researcher Chad Bouton and his team began collaborating with Ohio State Neurological Institute researchers and clinicians Rezai and Dr. Jerry Mysiw to design the clinical trials and validate the feasibility of using the neural bypass technology in patients.



Patient Ian Burkhart, seated, poses with members of the research team (from left) Dr. Ali Rezai and Dr. Marcie Bockbrader of The Ohio State University Wexner Medical Center and Nick Annetta of Battelle during a neural bypass training session. Credit: The Ohio State University Wexner Medical Center

"In the 30 years I've been in this field, this is the first time we've been able to offer realistic hope to people who have very challenging lives," said Mysiw, chair of the Department of Physical Medicine and Rehabilitation at Ohio State. "What we're looking to do is help these people regain more control over their bodies."

During a three-hour surgery in April 2014, Rezai implanted a computer chip smaller than a pea onto the motor cortex of Burkhart's brain.

The Ohio State and Battelle teams worked together to figure out the correct sequence of electrodes to stimulate to allow Burkhart to move his fingers and hand functionally. For example, Burkhart uses different brain signals and muscles to rotate his hand, make a fist or pinch his fingers together to grasp an object. As part of the study, Burkhart worked for months using the electrode sleeve to stimulate his forearm to rebuild his atrophied muscles so they would be more responsive to the electric stimulation.

"During the last decade, we've learned how to decipher brain signals in patients who are completely paralyzed and now, for the first time, those thoughts are being turned into movement," said study co-author Bouton, who directed Battelle's team before he joined the New York-based Feinstein Institute for Medical Research. "Our findings show that signals recorded from within the brain can be re-routed around an injury to the spinal cord, allowing restoration of functional movement and even movement of individual fingers."

Burkhart said it was an easy decision to participate in the FDA-approved clinical trial at Ohio State's Wexner Medical Center because he wanted to try to help others with spinal cord injuries. "I just kind of think that it's my obligation to society," Burkhart said. "If someone else had an opportunity to do it in some other part of the world, I would hope that they would commit their time so that everyone can benefit from it in the future."

Rezai and the team from Battelle agree that this technology holds the promise to help patients affected by various brain and [spinal cord](#) injuries such as strokes and traumatic brain injury to be more independent and functional.

"We're hoping that this technology will evolve into a wireless system connecting [brain signals](#) and thoughts to the outside world to improve the function and quality of life for those with disabilities," Rezai said. "One of our major goals is to make this readily available to be used by patients at home."

Burkhart is the first of a potential five participants in a clinical study. Mysiw and Rezai have identified a second patient who is scheduled to start the study in the summer.

"Participating in this research has changed me in the sense that I have a lot more hope for the future now," Burkhart said. "I always did have a certain level of hope, but now I know, first-hand, that there are going to be improvements in science and technology that will make my life better."

**More information:** *Nature*, [DOI: 10.1038/nature17435](https://doi.org/10.1038/nature17435)

Provided by Ohio State University Medical Center

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