The future of medicine: Insert chip, cure disease?

Imagine a chip, strategically placed in the brain, that could prevent epileptic seizures or allow someone who has lost a limb to control an artificial arm just by thinking about it.

It may sound like science fiction, but University of Florida researchers are developing devices that can interpret signals in the brain and stimulate neurons to perform correctly, advances that might someday make it possible for a tiny computer to fix diseases or even allow a paralyzed person to control a prosthetic device with his thoughts.

Armed with a $2.5 million grant they received this year from the National Institutes of Health, UF researchers from the College of Medicine, the College of Engineering and the McKnight Brain Institute have teamed up to create a “neuroprosthetic” chip designed to be implanted in the brain. They are currently studying the concept in rats but are aiming to develop a prototype of the device within the next four years that could be tested in people.

The initial goal? To correct conditions such as paralysis or epilepsy.

“We really feel like if we can do this, we’ll have the technology to offer new options for patients,” said Justin Sanchez, director of the UF Neuroprosthetics Research Group and an assistant professor of pediatric neurology, neuroscience and biomedical engineering. “There’s kind of a revolution going on right now in the neurosciences and biomedical engineering. People are trying to take engineering approaches for directly interfacing with the brain.

“The hope is we can cure more immediately a variety of diseases.”

Researchers have been able to decode brain activity for years using electroencephalography. Referred to commonly as an EEG, this technology involves placing a sensor-wired net over the head to measure brain activity through the scalp. But the technology wasn’t quite sensitive enough to allow researchers to decode brain signals as precisely as needed, Sanchez said. Now researchers are focusing on decoding signals from electrodes placed directly into the brain tissue using wires the width of a strand of hair.

“(Scientists have) realized that by going inside the brain we can capture so much more information, we can have much more resolution,” Sanchez said.

The chip UF researchers are seeking to develop would be implanted directly into the brain tissue, where it could gather data from signals, decode them and stimulate the brain in a self-contained package without wires. In the interim, UF researchers are studying implantable devices in rats and are evaluating an intermediate form of the technology — placing electrodes on the surface of the brain — in people.

UF researchers have developed new techniques using surface electrodes to access signals almost as precisely as they could with sensors implanted in the brain, according to findings the researchers published in May in the *Journal of Neuroscience Methods*. Developing these techniques is a big step forward in understanding how to best decode a patient’s intent from their brain waves and should have broad implications for delivering therapy, Sanchez said.

To gather data about the brain’s sophisticated cues, which vary from person to person, Sanchez studies the brain signals of children with epilepsy who are scheduled to undergo surgery to remove the part of the brain that is causing seizures. These patients often must be monitored for several days to weeks with electrodes

placed directly on the brain. Doctors use this to pinpoint the problem area when a child has another seizure.

Because the children already have electrodes in place, Sanchez is able to use the data gathered from them to understand more about the brain's signals in general.

UF researchers are also working on intermediate concepts that could be wearable, like a diabetes pump, Sanchez said.

"We have intermediate designs that connect to the brain, interpret signals and can wirelessly send commands to devices," he said. "This is another path of technology we're pursuing."

To create these technologies, Sanchez is in the process of developing a center for brain-machine interfaces at UF with faculty from the College of Engineering, including Jose C. Principe; John G. Harris; Toshikazu Nishida; and Rizwan Bashirullah.

But several challenges face researchers in bringing these technologies to patients, said Dr. Steven J. Schiff, a professor of engineering and neuroscience at The Pennsylvania State University and director of the Penn State Center for Neural Engineering.

For patients with epilepsy, who often have to take several medications or undergo surgery for relief from debilitating seizures, a neuroprosthetic device could be the best form of treatment, Schiff said, adding that more work needs to be done to understand the mechanics of what causes diseases such as epilepsy and Parkinson's.

"The challenge is not so much the technology," Schiff said. "The challenge is to use that technology wisely."

The day may not be too far off when patients can control a prosthetic hand or leg just by thinking about it, Sanchez said.

"It's becoming a reality," Sanchez said. "We're designing electronics that we can interface with biological systems and we can use that to help people."

Source: University of Florida