With more than 20 drugs on the market and a number of surgical procedures, the options for treating epilepsy are better than ever. Still, these treatments don't work for everyone.

Now NIH-funded researchers have developed a flexible brain implant that could one day be used to guide surgery with greater precision – or perhaps even to control seizures by delivering electrical stimulation to the brain.

Dr. Jonathan Viventi, an engineer and neuroscientist at New York University, earned his Ph.D. working on this kind of technology.

JV: So I started working on this project with Brian Litt at the University of Pennsylvania. He's a clinical neurologist and he treats patients with epilepsy, and when we were working together on this, I was a PhD student in his lab and his motivation was we really need better technology to understand epilepsy on a much finer scale.

Litt and Viventi set out to improve a device called an electrode array. These arrays contain tiny sensors – or electrodes – that can be used to record seizure activity in the brain. They're useful when anti-epileptic drugs have failed and doctors are considering surgery. With an array, doctors can assess where seizures are occurring in the brain and whether it's safe to remove the offending areas.

But current arrays also have some major drawbacks, says Viventi.

JV: So the currently available technology that we use to perform mapping of epileptic seizures in patients relies on some very old technology. There are individual pieces of metal that are wired with one wire for each contact, so that requires that we place these devices very far apart with very limited coverage of brain activity we're interested in.

Viventi and Litt have developed electrode arrays that have compact wiring embedded into a flexible material. With these arrays, it's possible to get broader coverage over the brain, and to reach into its grooves and folds. To make the arrays, Viventi and Litt needed some materials science expertise from John Rogers and his lab at the University of Illinois.

JV: They've developed a technique for making silicon that is flexible and stretchable and making active circuitry. And we worked with them to develop medical applications of their technology. The device we make is now…it's a thin sheet of plastic that integrates active circuitry – the same kind of transistors and devices that you would have in your MP3 player or cell phone – and is made out of a flexible material that we can bend and conform to match the curvature of the brain. This allows us to get a very detailed and high resolution picture of the activity in the brain in a way that's not currently possible with existing technology.

Viventi, Litt and Rogers recently published some of their first efforts to test these devices. They did the research on cats, which have brains that are anatomically similar to the human brain, but with more simple grooves and folds.

JV: We did three different examples of neural activity in our paper to show varied uses the technology can be used for. We looked at some basic neuroscience type questions. We looked at recording sleep spindles, which are naturally occurring events that occur while you're sleeping or while you're under anesthesia. We also looked at the visual system – how can this technology be used to better understand how the visual system works and how we could study large areas of that system simultaneously. And then finally we looked at an epileptic seizure induced on the brain and we found different spatial patterns. We found waves moving across the brain during the seizure that we haven't been able to observe before.

Viventi is quick to point out that the seizures he and his collaborators recorded in cats are not epilepsy per se. The cats were given a drug to induce seizures. But he thinks that the patterns of electrical activity seen in these experiments could hold clues for how seizures begin and how to control them.

JV: We've found that during seizures, there appear to be waves that look like they are spiraling across the surface of the brain. And that gives us interesting options for potentially treating that that seizure. We could potentially stimulate at the correct place and the correct time with the correct spatial pattern and try and abort that epileptic pattern from occurring.

More animal studies are in the immediate future, but human trials are the ultimate goal, Viventi says.

JV: We're looking to scale the technology up to larger sizes to record from larger areas of brains in larger animals and eventually transition to being able to take this technology into humans for preliminary studies to see if these same patterns occur in human epilepsy patients.

This has been Daniel Stimson reporting for the National Institute of Neurological Disorders and Stroke, part of the National Institutes of Health.