Medical Xpress

Advanced technology reveals activity of single neurons during seizures

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The first study to examine the activity of hundreds of individual human brain cells during seizures has found that seizures begin with extremely diverse neuronal activity, contrary to the classic view that they are characterized by massively synchronized activity. The investigation by Massachusetts General Hospital (MGH) and Brown University researchers also observed pre-seizure changes in neuronal activity both in the cells where seizures originate and in nearby cells. The report will appear in *Nature Neuroscience* and is receiving advance online publication.

"Our findings suggest that different groups of neurons play distinct roles at different stages of seizures," says Sydney Cash, MD, PhD, of the MGH Department of Neurology, the paper's senior author. "They also indicate that it may be possible to predict impending seizures, and that clinical interventions to prevent or stop them probably should target those specific groups of neurons."

Epileptic seizures have been reported since ancient times, and today 50 million individuals worldwide are affected; but much remains unknown about how seizures begin, spread and end. Current knowledge about what happens in the brain during seizures largely comes from EEG readings, which reflect the average activity of millions of neurons at a time. This study used a neurotechnology that records the activity of individual brain cells via an implanted sensor the size of a baby aspirin.

The researchers analyzed data gathered from four patients with focal epilepsy – seizures that originate in abnormal brain tissues – that could not be controlled by medication. The participants had the sensors implanted in the outer layer of brain tissue to localize the abnormal areas prior to surgical removal. The sensors recorded the activity of from dozens to more than a hundred individual neurons over periods of from five to ten days, during which each patient experienced multiple seizures. In some participants, the recordings detected changes in neuronal activity as much as three minutes before a seizure begins and revealed highly diverse neuronal activity as a seizure starts and spreads. The activity becomes more synchronized toward the end of the seizure and almost completely stops when a seizure ends.

"Even though individual patients had different patterns of neural activity leading up to a seizure, in most of them it was possible to detect changes in that activity before the upcoming seizure," says co-lead and corresponding author Wilson Truccolo, PhD, Brown University Department of Neuroscience and an MGH research fellow. "We're still a long way from being able to predict a seizure – which could be a crucial advance in treating epilepsy – but this paper points a direction forward. For most patients, it is the unpredictable nature of epilepsy that is so debilitating, so just knowing when a seizure is going to happen would improve their quality of life and could someday allow clinicians to stop it before it starts."

Cash adds, "We are using ever more sophisticated methods to handle the large amounts of data we are collecting from patients. Now we are assessing how well we actually can predict seizures using ensembles of single neurons and are continuing to use these advanced recording techniques to unravel the mechanisms that cause human seizures and leveraging this knowledge to make the most of animal models." Cash is an assistant professor of Neurology at Harvard Medical School, and Truccolo an assistant professor of Neuroscience (Research) at Brown.

Provided by Massachusetts General Hospital