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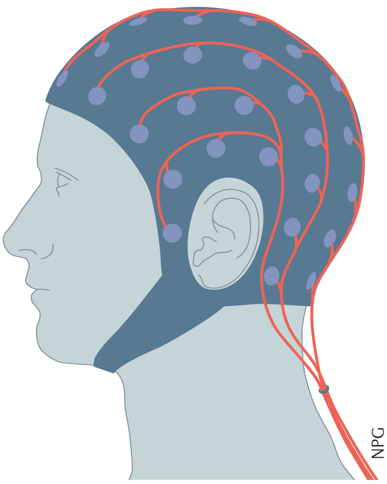
EPILEPSY

Noninvasive detection of deep brain seizures

Seizures in deep cortical regions have been detected with noninvasive recordings for the first time in a recently published study. A computational approach enabled detection of mesial temporal lobe seizures that conventional EEG did not pick up, opening the door to further understanding the role of these seizures in epilepsy and other neurological disorders.

Nonconvulsive seizures in deep brain regions such as the mesial temporal lobes are known to occur in patients with epilepsy, and some evidence suggests that they also occur in Alzheimer disease (AD). Many of these seizures are undetectable because they produce no conventional EEG signal; consequently, they are known as 'scalp-negative seizures'.



> the algorithm correctly detected scalp-negative seizures in 40% of patients

"To detect scalp-negative seizures, we typically use invasive intracranial electrodes to measure activity directly from these deep brain regions," explains lead author of the new paper, Alice Lam. "To avoid the risk and expense of such a procedure, we decided to develop a noninvasive method to detect this deep seizure activity."

To develop their detection system, Lam and colleagues used existing data from 23 patients with epilepsy who had undergone presurgery evaluation with simultaneous EEG and invasive foramen ovale electrode recordings. EEG recordings from 10 patients with and 13 patients without scalp-negative seizures were compared, allowing identification of seizure-specific patterns that formed the basis of an algorithm to identify scalp-negative seizures according to EEG coherence features.

The algorithm was validated by estimating its performance with new patients. Using only EEG data, the algorithm correctly detected scalp-negative seizures in 40% of patients who experienced them, with a positive predictive value of 75%. False alarms occurred in just 8% of controls without scalp-negative seizures. "This is a notable improvement from the status quo, where we are unable to identify any of these seizures using routine clinical EEG interpretation," says Lam.

Principal investigator Sydney Cash points out that the technique not only has clinical implications for identifying patients with these seizures, but might also provide fundamental insight into the mechanisms of scalp-negative seizures. "The results suggest that the way we think about seizures as being very focal may not be entirely true, and perhaps more of the cortical network is involved," he says. "The fact that we can use the scalp to find out what is happening deep inside hints that those deep events are still involving more-superficial regions of cortex."

The work also paves the way for further development of computational methods to study deep brain seizures, and makes these seizures easier to study in conditions other than epilepsy. "We are interested in applying these methods to investigate whether subclinical mesial temporal seizures are common among people with AD and other neurodegenerative disease, and whether this has important implications for altering disease trajectory in these patients," says Lam.

Ian Fyfe

ORIGINAL ARTICLE Lam, A. D. *et al.* Widespread changes in network activity allow non-invasive detection of mesial temporal lobe seizures. *Brain* http://dx.doi.org/10.1093/brain/aww198 (2016)