Oscillatory Activity Originating at Network Lesion Boundaries: A Model for Early Posttraumatic Epilepsy

Elan L. Ohayon, Maxim Bazhenov, Terrence J. Sejnowski, Igor Timofeev, Paul W. Tsang, Donald S. Borrett, Hon C. Kwan, and McIntyre W. Burnham; La Jolla, CA; Toronto, Ontario, Canada; and Quebec City, Quebec, Canada

Anatomical damage to neuronal networks can lead to substantial alterations in system dynamics. An archetypal example, for which the pathophysiological mechanisms remain largely unknown, is early posttraumatic epilepsy. Changes in intrinsic cell properties are often postulated to be the causal factors. However, localized changes in network structure may be sufficient to explain the effects of lesions on brain dynamics without assuming changes to cell properties. We demonstrate this principle in computational models (ranging from 900 to 10,000 cells) in which certain balanced conditions are disturbed by the introduction of even a small lesion. Reduced feedback between boundary cells after lesioning lowers mutual damping effects, thereby allowing for high-amplitude synchronous activity to begin at the lesion boundary. Once this activity is initiated it may propagate far beyond the site of damage. This study suggests that phenomena such as hyperexcitability and synchrony following lesions or cell death may be due to changes in network connectivity, which

would explain the increased risk of early seizures following trauma. These principles may also underlie changes in EEG accompanying other types of cell loss in the CNS, such as Alzheimer's, Parkinson's, and CJD. Study supported by the Canadian Institutes of Health Research – Institute of Neurosciences and by a Mental Health and Addiction Ohayon Doctoral Research Award.