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Graph theoretical analysis may help predict recovery of motor function after stroke

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Graph theoretical analysis is proving to be helpful in understanding complex networks in the brain. Investigators in the Republic of Korea used a graph theoretical approach in examining the changes in the configuration of the two hemispheres of the brain in 12 patients after stroke. They found it helped understand the dynamic reorganization of both hemispheric networks in the brain and to predict recovery of motor function. Their findings are published in *Restorative Neurology and Neuroscience*.

Graph theoretical analysis is a powerful new tool for characterizing functional neural networks that is being used to improve understanding of neurological disorders such as Alzheimer's disease, schizophrenia, epilepsy, and traumatic brain injury.

"The physiological effects of neurological disorders are best assessed over an entire network, rather than just being locally assessed at the site of damage," explained lead investigator Yun-Hee Kim, MD, PhD, Professor in the Department of Physical and Rehabilitation Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea. "We therefore investigated the reorganization of network topology in both the ipsilesional hemisphere (the side of the brain affected by stroke) and the contralesional hemisphere. We also tried to predict the recovery of motor function by examining the relationship between specific network measures immediately after onset and an enhanced motor function score three months after stroke."

All 12 patients underwent resting-state functional magnetic resonance imaging (fMRI) - a functional neuroimaging procedure using MRI technology that measures brain activity by detecting changes associated with blood flow - within two weeks after stroke onset and subsequently one, three, and six months later. Motor impairment in upper and lower extremities was measured on the same day as the fMRI procedures.

The investigators found that the ipsilesional hemispheric network showed active reorganization during recovery. The randomness of the network significantly increased for three months post-stroke, but after three months, there was no significant reorganization in either hemisphere.

Predicting the recovery of motor function is crucial for rehabilitation planning and therapy development. The investigators describe an indicator for predicting the recovery of motor function from graph indices: the characteristic path length (CPL). By examining the characteristics of the network topology, the investigators discovered that the proportional CPLs could be an indicator of recovery prediction. The lower the CPL of the ipsilesional hemispheric network immediately after onset, the better the recovery shown after three months.

"The graph theoretical approaches of the network in each hemisphere were helpful for understanding dynamic reorganization of brain network after a stroke and finding an important implication for recovery, although the precise biological mechanisms of recovery after a stroke must still be determined," said Dr. Kim. "We expect that our findings will become one of the important implications for clinical research and therapeutic plans."

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