Department of Biomedical Engineering  
Marquette University

Announcement of Public Dissertation Defense

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2:00 pm  
Engineering Hall, Room 236

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ABSTRACT

Structural-Functional Brain Connectivity Underlying Integrative  
Sensorimotor Function after Stroke

In this dissertation research project we demonstrated the relationship between the structural and functional connections across the brain in stroke survivors. We used this information to predict arm function in stroke survivors, suggesting that the tools developed through this research will be useful for prescribing individualized rehabilitation strategies in people after stroke. Current clinical methods for rehabilitating sensorimotor function after stroke are not based on the locus of injury in the brain. Instead, therapies are generalized, treating symptoms such as weakness and spasticity. This results in outcomes that are highly variable, with severity of impairment immediately following stroke as the best predictor of recovery. By using measures of brain structural and functional relations, we can better prognosticate and plan rehabilitation interventions.

This research study utilized diffusion and functional magnetic resonance imaging (MRI) to quantify anatomical connectivity and functional networks of the brain after stroke. In the first aim, diffusion MRI was used to track the white matter pathways throughout the entire brain. A new imaging biomarker sensitive to stroke lesions was developed that quantifies the level of anatomical connections between every point in the brain. It was found that cortical areas most responsible for integration of sensorimotor and multisensory integration were the best predictors of motor impairments in chronic stroke subjects. Our second aim investigated the role of multisensory integration during sensorimotor control in healthy adults and stroke survivors. A novel functional MRI task paradigm involving wrist movement was developed to gain insight into the effects of multimodal sensory feedback on brain functional networks in stroke subjects. We found that the loss of functional interactions between the cerebellum and lesioned sensorimotor area were correlated with loss of movement function. Our final aim investigated the relationship between structural and functional connectivity after stroke. A model that marries diffusion MRI fiber tracking and resting-state functional MRI was designed to enhance indirect functional connections with structural information. The technique was capable of detecting changes in cortical networks that were not seen in functional or structural analysis alone. These changes were associated with movement performance. In conclusion, structure is essential to functional networks and ultimately, recovery of functional movements after stroke.