Complex networks in the evaluation of brain injury therapy

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Acquired Brain Injury (ABI) constitutes one of the leading causes of mortality and disability around the world . The mechanisms that take place within the brain during the recovering process and the way cortical reorganization occurs have not been completely unveiled. Due to contradictory results reported in literature about the increase or decrease of neuronal activation after rehabilitation, we consider necessary to deal recovering from a point of view that takes into account the changes in interaction between brain areas, not just measuring the local changes in patterns of activation. Modern neuroscience research has shown that the notion of localized brain functions is insufficient, especially when dealing with higher brain functions. Indeed, cognitive functions in the brain require the functional interactions between multiple distinct neural networks. The idea that the brain is a complex network of dynamical systems with abundant interactions between local and more remote brain areas with the potential capability to compensate for lesions optimally fit with the study of the brain strategies for brain injury rehabilitation. Although anatomical reorganization also occurs in the cortex immediately after a lesion-induced injury, the extension of this phenomenon to distant but interconnected areas has not been demonstrated. However, patients with ABI often undergo from diffuse alteration of cognitive functions that cannot be explained by a focal alteration of their brain functions, probably because lesion interferes with widespread functional networks in the brain and not only in the adjacent region of the lesion. Most studies have focused on local dysfunction, reporting changes observed just in the spatial dimension of analysis. Our point of view is to study the impact of a lesion on the brain on the functional interactions (functional connectivity) that takes place between brain regions. In the study of such interaction between brain areas the concept of functional connectivity has emerged, referring to the statistical interdependencies between physiological time series recorded in various brain areas simultaneously. Functional connectivity is, probably, an essential tool for the study of brain functioning, and their deviation from healthy patterns could be used as a reflect of lesion. To our knowledge, studies researching functional connectivity in ABI patients and comparing with healthy controls in order to check the recovering have not been performed yet. In this work we aim to capture differences in connectivity pattern properties, from the point of view of graph theory, in ABI patients before and after a rehabilitation treatment. In this work, we show as the nerwork theory tool help us to quantify and determine the network restoring, using different parameters that evaluate the changes both in the global, lobe and local scales.