Severity of motor deficit and spasticity affects brain functional connectivity of stroke patients.

Nabila Brihmat[1], Evelyne Castel-Lacanal[1,2], Xavier De Boissezon[1,2], Claire Lebely[3], Helene Gros-Dagnac[1], Isabelle Loubinoux[1], Philippe Marque[1,2].

1 ToNIC, Toulouse NeuroImaging Center, Université de Toulouse, Inserm, UPS, France.
2 Department of Rehabilitation and Physical Medicine, Pôle Neurosciences, Centre Hospitalier Universitaire de Toulouse CHU, Toulouse, France.
3 Inserm CIC 1436, CHU Toulouse, Université Toulouse III Paul Sabatier, Toulouse, France.

Abstract

Introduction

Motor rehabilitation after stroke is challenging, especially for individuals who exhibit spasticity along with motor impairment. Spasticity, which affects more than 42% of stroke survivors, can limit effective practice of coordinated movement and functional recovery (Welmer, Von Arbin, Holmqvist, & Sommerfeld, 2006; Wissel, Manack, & Brainin, 2013). A more complete restoration of motor function is achieved when spasticity is absent (Ryu, Lee, Lee, & Chun, 2010). Resting-state functional magnetic resonance imaging (rs-fMRI) has been used to examine brain mechanisms of stroke patients with hemiplegia (Park et al., 2011; Zhang et al., 2017), but the relationship between functional connectivity (FC) changes and spasticity symptoms has not yet been fully investigated. This study aimed to identify the brain FC of stroke patients with spasticity and to study the relationship between FC and motor function or spasticity severity using rs-fMRI and clinical scales.

Methods

Twelve subacute post-stroke spastic patients (PSSP) were recruited in this study (2 females, mean age = 58.1 ± 15.8 years; time post-stroke = 5.6 ± 1.7 weeks; Fugl-Meyer Scale = 44.8 ± 26.6 / 100; range [12:96]; Modified Tardieu Scale = 9.4 ± 2.6 / 16; range [5:14]). We investigated the FC between selected seed regions of the non-lesioned and lesioned sensorimotor network and each voxel throughout the brain using the conn toolbox. Additionally, correlations among brain FC measures and behavioral scores assessing motor function (FMS scores) and spasticity severity (MTS score) were computed. The results were thresholded using a combination of uncorrected voxel-level p-value at $p<0.001$ and FDR-corrected cluster-level p-value at $p<0.05$.

Results

Statistically significant correlations were found between the brain measures of FC and the clinical severity of the motor deficit and spasticity of the PSSP included. For the motor function, the FC between the regions of the ipsilesional sensorimotor network (SMN), namely the precentral, postcentral gyri and the superior parietal lobe, and the regions of the contralesional frontal and prefrontal cortices and ipsilesional cingulum were found negatively correlated with the FMS scores of the stroke patients (Fig. 1A). Meanwhile, the FC between the contralesional precentral gyrus and the precuneus (BA 7) was found positively correlated with the FMS scores (Fig. 1B). For spasticity, the decrease in FC between the regions of the ipsilesional sensorimotor network and the contralesional supramarginal gyrus (BA 40) was associated with the increase of spasticity scores (Fig. 2).

Conclusion

Our results revealed increased connections of key nodes of the ipsilesional motor network in stroke patients suffering from motor deficits and spasticity, connections that affect regions beyond the SMN such as prefrontal areas and that are associated with poor motor function. In parallel, increased functional connectivity between the contralesional precentral gyrus and the medial posterior cortex is also found associated with better motricity and may sustain compensatory networks (Dodd, Nair, & Prabhakaran, 2017). More spasticity resulted in less connectivity between the ipsilesional primary motor cortex and the contralesional parietal lobe. These results suggest that FC could serve as a biomarker of motor recovery in stroke patients with hemiparesis and highlight the clinical value of these findings for spasticity treatment purposes.

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