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Alterations in Brain Network Topology between Supra- and Infra-tentorial Stroke Patients

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Objective

In recent stroke studies, connectivity-based approaches have been widely used to investigate recovery-related indicators of network structure. However, most of previous studies were performed in heterogenous stroke patients with different types and lesion locations. In addition, there is a lack of research on infratentorial stroke (ITS) and very few comparative studies between supratentorial stroke (STS) and ITS. We investigated the differences in alteration of motor networks between STS and ITS in ischemic stroke patients.

Materials and Methods

Forty subcortical ischemic stroke patients were recruited within two weeks after their stroke onset. There was no significant differences in demographic and clinical characteristics between STS group (12 males and 9 females, age 57.8±11.2 years, initial motor function FMA 44.5±19.7) and ITS group (13 males and 6 females, age 59.7±12.0 years, initial motor function FMA 44.8±22.1). All patients underwent resting-state functional MRI scans twice (2 weeks and 3 months after stroke onset). Healthy subjects participated as an age-matched healthy control group (14 males and 10 females, age 58.4±10.4 years). To investigate the altered connectivity during recovery and compare between groups, various methods (interhemispheric connectivity, network symmetry, and graph theoretical analysis related to global network characteristics) that were used in existing studies were used.

Results

Stroke onset significantly disrupted interhemispheric balance in the STS group only. Contrary to the STS group, drastic disruptions of these measures did not occur in the ITS group. During recovery, measures related to interhemispheric balance were significantly changed in the ITS group, whereas measures related to global network reorganization were significantly changed in the STS group (Figure 1). The altered network measures in each group were correlated with their motor functions. Cortico-cerebellar connectivity interacted with interhemispheric cortical connectivity only in the ITS group (Figure 2).

Conclusions

These results revealed that changes in the motor network and recovery-related network measures differ according to lesion location. Recovery after ITS occurred through restoration of interhemispheric balance contributed by the cortico-cerebellar connectivity. In contrast, recovery after STS occurred through global network reorganization. These findings may indicate that characteristic motor network dynamics during recovery phase of stroke result from different interactions between cortico-cortical and cortico-cerebellar connectivity dependent to lesion location. These may also give an implication for establishing neurorehabilitation strategies in terms of target site determination by non-invasive brain stimulation.

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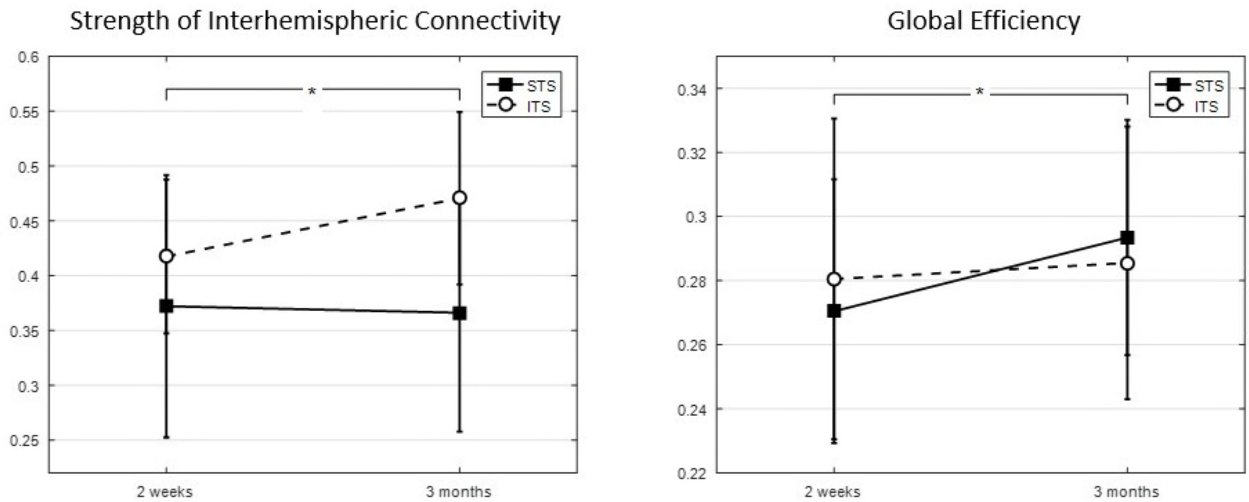

Figure 1. Changes in interhemispheric connectivity and global efficiency during recovery. Interhemispheric connectivity increased in the ITS group only. Global efficiency decreased significantly during recovery in the STS group only (* p<0.05).

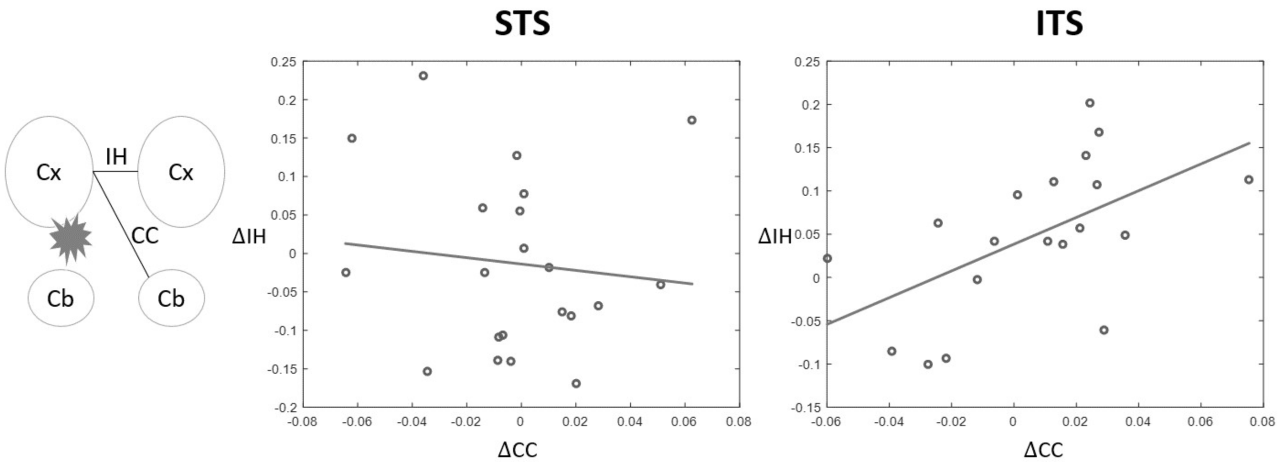

Figure 2. Relationship between interhemispheric cortical connectivity and cortico-cerebellar connectivity. A change of interhemispheric cortical connectivity and a change of cortico-cerebellar connectivity in the STS and the ITS groups. A change of interhemispheric connectivity was correlated with a change of affected cortico-cerebellar connectivity in the ITS group only (p=0.0127). Cx, cerebral cortex; Cb, cerebellum; IH, interhemispheric connectivity; ΔIH = IH (three months) – IH (two weeks); CC, cortico-cerebellar connectivity; ΔCC = CC (three months) – CC (two weeks).