Post-stroke impairment

PHYSIOTHERAPY RESEARCH FOUNDATION Dr Brenton Hordacre, APAM, received a PRF Seeding Grant in 2015. Here, he provides an update on his endeavours.

Project overview

Stroke can lead to significant impairments, often requiring extensive rehabilitation and therapy to optimise functional recovery. Several factors, such as lesion size and location, are known to contribute to the subsequent level of impairment following a stroke. However, even for stroke survivors with lesions which appear similar in size and location on neuroimaging, there can be variability in residual function. It may be that reserve pathways, or redundancy, within brain networks are able to compensate for various pathological insults, such as stroke, to some degree. Understanding factors which contribute to post-stroke impairment are likely to have important implications for rehabilitation therapies and service delivery. Therefore, this study investigated whether motor network reserve was associated with the change in upper limb function in a stroke model.

Methodology

In this preliminary investigation, we modelled stroke in 18 healthy adults using non-invasive brain stimulation (NIBS). In one session, NIBS was applied to the motor cortex to (temporarily) suppress cortical excitability, which provides a model similar to what observed following a lesion of the motor cortex. A second control session was performed with sham non-invasive brain stimulation which did not change cortical excitability. Prior to receiving non-invasive brain stimulation, connectivity between cortical brain regions was investigated using high-density electroencephalography (EEG). Connectivity was used as a marker of brain reserve, with stronger connectivity reflecting greater reserve, or redundancy, in brain networks. Upper limb function was assessed at baseline, and following non-invasive brain stimulation using the Perdue Pegboard Test and a customised pinch-grip manipulandum, with a change in function used as a marker of impairment.

Current leading research

We know from recent studies that connectivity between motor regions in the brain is an important marker of motor function. Both animal and human work has demonstrated that recovery of motor function following stroke is paralleled, to some extent, by restoration of connectivity between motor regions. Whether connectivity prior to a stroke is associated with subsequent impairment or recovery has not been investigated, most likely due to the inability to measure connectivity prior to a stroke occurring.

We were able to achieve this by modelling stroke using NIBS. Our results indicated that the experimental stroke model was successful, as impaired motor performance of the hand was observed for active non-invasive brain stimulation, but not sham. In addition, connectivity between sensorimotor and frontal brain regions predicted 71 per cent of variability in impaired motor function following the active non-invasive brain stimulation session. This result suggests that motor reserve may be an important marker of upper limb impairment.

An additional finding was that the magnitude of change in cortical excitability following non-invasive brain stimulation was associated with connectivity of motor network (since published in the *European Journal of Neuroscience*). While several factors are known to contribute to the response following non-invasive brain stimulation, this was the first report demonstrating that connectivity may be an important marker. Given the high response variability to non-invasive brain stimulation, this finding was important, as it may allow prediction of participants likely to respond strongly to brain stimulation.

Impact on clinical practice

The potential impact for clinical practice is difficult to judge from this preliminary study, and further investigations with stroke patients are required. However, we have shown for the first time that brain reserve, measured as connectivity, prior to an experimental model of stroke, is an important marker of subsequent impairment in hand function. Therefore, motor network connectivity could be an important biomarker, which may help predict capacity for recovery and streamline patients to appropriate physio and rehab programs.

Furthermore, NIBS as a treatment modality to facilitate recovery of motor function and optimise rehabilitation outcomes has shown some promise, but reliability is currently poor. Results suggest that connectivity of the motor network was associated with the response to NIBS, and with further investigation, could be a tool to screen patients and select those most appropriate for brain stimulation therapy.

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