INDUCTION OF CORTICAL REORGANISATION FOR REHABILITATION IN STROKE

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page

Abstract

Stroke is a cerebrovascular injury to the brain leading to neural tissue death and is the leading cause of long-term disability in the world today. My primary goal in this study was to examine the possibility that reorganisation in the stroke-affected brain could be made in a manner that supported improved motor function. To achieve this, I induced reorganisation of the motor cortex by stimulating peripheral afferents, in both normal subjects and stroke-affected patients. I also carried out a series of experiments examining the reliability of the test methods used to evaluate cortical function, and to induce functional changes in the motor cortex.

Reorganisation is possible in the neural networks of the adult nervous system following alteration of afferent inputs brought about by conditions such as motor learning or by injury. This concept of dynamic functional plasticity in the nervous system provides the foundation for the development of learning and memory throughout life and offers a potential for repair and recovery in pathological conditions. The stroke-injured brain is capable of reorganisation; hence, rehabilitation techniques should be aimed at enhancing possible mechanisms for the brain to compensate for the lesion through reorganisation or brain plasticity.

I used the technique of transcranial magnetic stimulation (TMS) to examine corticomotor function, and a series of functional tests to examine motor performance. My first series of experiments in this thesis investigated the stability of TMS map parameters over time in healthy individuals. The areas of the scalp from which responses were evoked from corticospinal cells projecting to three intrinsic hand muscles were systematically mapped with TMS at intervals of 24 hours, one week and two weeks from eight normal subjects. The area, volume and centre of gravity of these maps did not change significantly over this

period. I concluded that the conventional method for mapping the cortical representational areas of individual hand muscles gives maps that are stable over periods of up to two weeks. This validates the use of such maps for the investigation of both short-term and long-term effects of interventions that may modify the cortical representation of muscles.

I induced prolonged changes in the excitability of the motor cortex in a group of stroke patients using the technique of dual stimulation. This combines a central stimulus (TMS) with electrical stimulation of afferent nerves. The experiments described in Chapters 4 and 5 aimed to determine the effect of dual stimulation on cortical reorganisation and motor function in a group of stroke patients. Chapter 4 describes the results of my intervention on stroke-affected lower limbs and chapter 5 on upper limbs. Neurophysiological and functional changes were seen in the affected upper and lower limb muscles. Some stroke-affected individuals showed marked neurophysiological and functional changes. Furthermore, stroke-affected subjects who had the largest changes in neurophysiological measures were also the ones with the largest change in functional measures. However, the effect of the intervention was highly variable and the overall changes in the group scores were not statistically significant.

The final series of experiments described in this thesis (Chapter 6) investigated the effects of a short period of anodal direct current (DC) stimulation and peripheral nerve stimulation on corticospinal excitability. The effect of this combined DC stimulation and peripheral nerve stimulation was contrasted with peripheral nerve stimulation alone. It demonstrated that the effects of peripheral nerve stimulation on cortical excitability could be potentiated by a preceding period of DC stimulation.