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New aspects of single pulse TMS and repetitive TMS: from clinical point of view

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Transcranial magnetic stimulation (TMS) has been applied to many neurological patients for more than 20 years. Single pulse TMS was used for the first ten years to study the pathophysiology of many disorders, especially abnormality in the corticospinal tracts. Repetitive TMS was introduced more than ten years ago. It has been used to treat the patients as well as for studying pathomechanisms. In this communication, I will review a few issues of TMS.

Single pulse TMS

Central motor conduction

The conduction times between the motor cortex, brainstem and spinal cord were estimated from the differences in latency between motor evoked potentials (MEPs) to two sites of stimulation. These indicate the impulse conduction time from one stimulation site to another site of stimulation. Based on the conduction times, we can speculate the number of corticospinal tracts lesions and their sites, which will help us to manage the patients. I will show some usefulness of single pulse TMS in patients with pyramidal tracts lesions.

Motor root stimulation

MEPs to TMS over the spinal cord can give us information about the conduction times through the most proximal parts of peripheral nerves. Several peripheral nerve disorders involve mainly the proximal parts of nerves. In such disorders, TMS is very useful in diagnosis because the proximal parts of peripheral nerves could not be studied before TMS period. I will show some patients in whom motor root TMS was very useful for the diagnosis.

Paired pulse TMS

Paired pulse TMS over the motor cortex

Two successive TMS are given to the same motor cortex with a special device which enables us to give two stimuli separated by very short interval (longer than 1ms) in the same coil. The first TMS can modulate MEPs to the second TMS. At short intervals, the first stimulus inhibits MEPs to the second stimulus. It is called as short interval intracortical inhibition (SICI) which reflects GABAergic function of the primary motor cortex. This inhibition was reduced in some disorders in which central inhibitory system is involved. I will show results of normal subjects and abnormal findings in a few kinds of disorders.

Cerebellar stimulation and motor cortex

The cerebellum plays important roles in motor control and its damage causes incordination. The coordination is maintained by continuous monitoring and modulating the primary motor cortex by the cerebellum. To mimic this modulation, we give the first TMS over the cerebellum and the second TMS over the contralateral motor cortex. The cerebellar stimulation suppressed MEPs to the motor cortex. The inhibition is considered to be produced by the Purkinje cells activation through cerebello-thalamo-cortical pathways. Normal and abnormal results of cerebello-motor cortical stimulation will be presented in this communication.

Repetitive TMS (rTMS)

Biphasic rTMS

rTMS can induce long lasting effects on the cortical areas under the coil and also distant area having a connection with the areas under the coil. These are considered to be the same as a long term potentiation (LTP) or long term depression (LTD). It has been applied for the treatment of several disorders. I will show some clinical trials of rTMS for

the treatment of some disorders.

The mechanisms for LTP/LTD were studied in humans and monkeys. Several changes in metabolism or physiological activity are shown after rTMS and some of them continued to be present for at least one week. These data will encourage us to use rTMS as a treatment.

Monophasic rTMS

Monopahsic rTMS has more powerfull long term effects than biphasic rTMS. We compared several physiological parameters after monophasic rTMS and biphasic TMS, and showed that monopasic rTMS produces longer lasting, more powerful long term effects. This stimulation has several physiological characteristics compatible with LTP/LTD. I will show such physiological characteristics. The monophasic rTMS must be a better method of stimulation for the treatment.