

이상운동질환에서 경두개뇌자기자극



신 해 원

중앙의대 신경과

Transcranial magnetic stimulation (TMS) in movement disorders

Hae-Won Shin, MD, PhD

Chung-Ang University Hospital

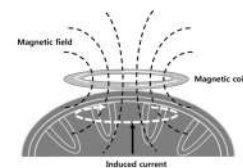
Today's talk

- What is TMS and rTMS
- Motor hot spot
- Resting motor threshold
- Stimulation intensity
- Stimulation sites

Transcranial magnetic stimulation



Transcranial magnetic stimulation TMS.
Image Credit: Rumruay / Shutterstock R By



Shin, 2011, 대한임상신경생리학회지

Transcranial magnetic stimulation -어떤 경우에 사용하는 tool 인가

Transcranial magnetic stimulation (TMS)

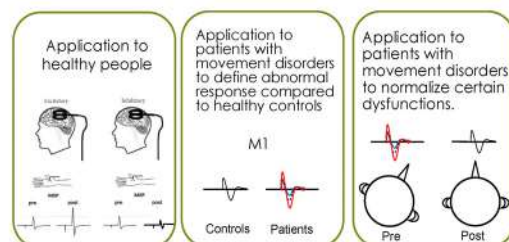
뇌의 기능에 일시적으로 장애를 일으켜서 시간과 공간에 대한 기능을 조사하는 방법

Repetitive TMS (rTMS)

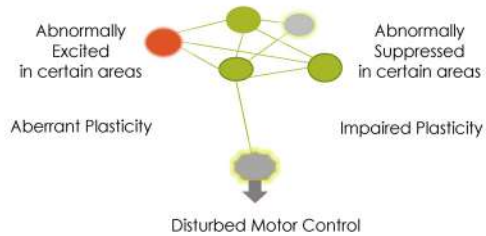
TMS 자극을 반복적으로 적용하면 자극시간을 넘어서서 뇌기능의 변화를 유도할 수 있다.

이 기전을 이용하여 다양한 뇌질환 환자의 뇌기능장애의 개선을 위하여 치료적으로 이용할 수 있을 것이라는 아이디어에 착안함

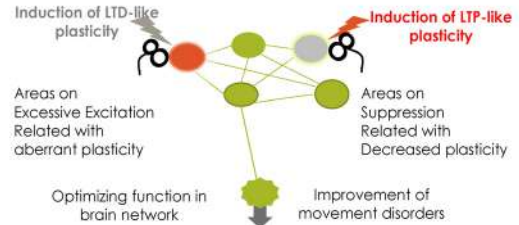
Development of a new rTMS protocol



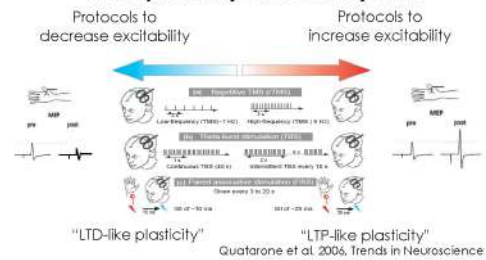
Movement Disorders as Brain Network Disorders



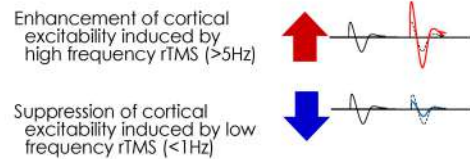
Rationale of application of TMS in Movement disorders



Brain plasticity induced by rTMS



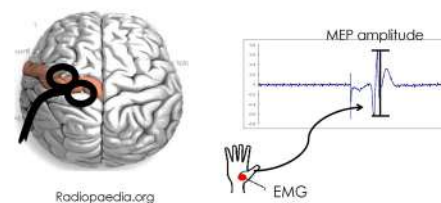
일반적인 TMS 기계로 할 수 있는 가장 쉬운 protocol



Transcranial magnetic stimulation 어디를 어떻게 자극하나

뇌 피질의 어느 곳에도 자극을 가할 수 있음
특히 운동피질 (primary motor cortex) 를 자극하는 경우
motor evoked potential (MEP) 라는 신경생리학적
parameter 의 측정을 통하여 감각적 가치의 수치를 획득
가능함.
운동피질 외 다른 영역을 자극할 때에도 stimulation intensity,
측정 위치 등을 정할 때 기본적으로 MEP 의 측정이 필요하
기 때문에 TMS study 에는 MEP, resting motor threshold
(RMT) 등, motor system 과 관련된 parameter 가 선행적
으로 측정되어야 한다.

Motor hot spot



Motor hot spot; navigation system



Brainsight TMS-neuroCare Group

Motor Threshold

Definition of motor threshold

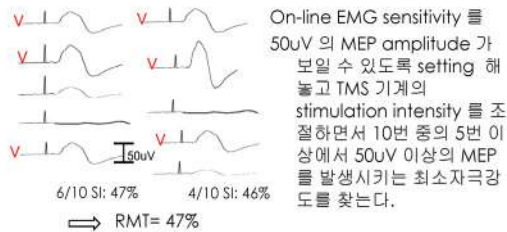
→ Minimal stimulation intensity producing MEPs in the target muscle

- **Resting motor threshold (RMT)**: minimal stimulus intensity required to produce MEPs of $>50\mu V$ in at least 5 out of 10 consecutive trials
- **Active motor threshold (AMT)**: minimum stimulus intensity required to produce MEPs of $>100\mu V$ in the moderately active muscle

RMT: excitability of a central core of neurons, depending on the excitability of individual neurons

RMT represents the neuronal membrane excitability

Resting motor threshold



Stimulation Frequency

Low frequency rTMS

$\leq 1\text{Hz}$

기능을 suppression 하고자 하는 부위

Dystonia

Tremor

High frequency rTMS

$\geq 5\text{Hz}$

기능을 enhancing 하고자 하는 부위

Bradykinesia

Freezing of gait

Depression

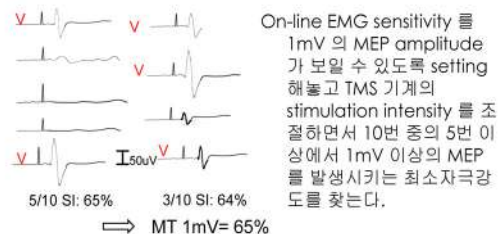
Stimulation intensity for rTMS

High frequency rTMS가 Low frequency rTMS에 비해서 low SI로 자극해야 안전하고 coil의 과열에

Protocol에 따라서 다르게 설정한다.
90% RMT, MT1mV, 120%AMT 등등...

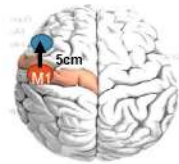
What is MT1mV?

MT 1mV

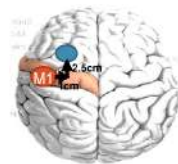


Stimulation site

Dorsolateral prefrontal cortex

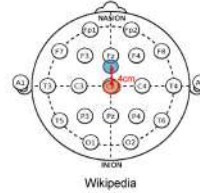


Dorsal premotor cortex

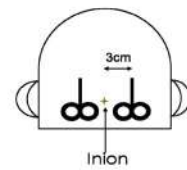


Stimulation site

Supplementary motor area



Cerebellum



Effective therapeutic rTMS in Movement Disorders

	Parkinson disease (Motor)	Parkinson disease (Depression)	Dystonia	Essential Tremor
rTMS protocols	High-frequency rTMS on M1 with multiple sessions	High-frequency rTMS on left DLPFC	Low-frequency rTMS on dorsal PMC in focal hand dystonia	Low-frequency rTMS on cerebellum

Example of rTMS protocol

Low frequency rTMS protocol

Frequency: 1Hz, stimulation intensity: 90% RMT

Multiple sessions, 600 pulses a day, 5 days

Stimulus

