Repetitive somatosensory stimulation in focal hand dystonia: a study on inhibitory circuitry plasticity of the somatosensory system and primary motor cortex

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Background

• Dystonia is a syndrome characterized primarily by unwanted muscle spasms giving rise to involuntary movements and abnormal postures
• Many forms of dystonia (idiopathic, genetic, associated with CNS lesions, etc.)
• Limited therapeutic options
• Pathophysiology unclear, but loss of inhibition in motor control seems plausible
  ➢ Inability to suppress undesired movements when a voluntary movement is performed

Hallett, 2011
Background

- Dystonia as a network disorder
- Multiple parallel/interacting pathophysiological processes

Alterations in inhibition/sensory function

Abnormal synaptic plasticity

Deranged sensorimotor integration

Dystonia

Jinnah et al., 2017; Latorre et al., 2020
• Paired-pulse somatosensory evoked potentials (PP-SEP)
• Early/late high-frequency oscillations (e-HFO, l-HFO)
• Somatosensory evoked potentials spatial inhibition ratio (SIR)

Ozaki et al., 2011; Rocchi et al., 2016
Background

- Cervical dystonia associated with decreased PP-SEP suppression, less SIR and smaller HFO area
- Correlation between PP-SEP with an interstimulus interval of 5 ms, l-HFO area and somatosensory temporal discrimination values
Background

RSS: repetitive somatosensory stimulation

- High-frequency RSS (HF-RSS): 20 Hz frequency, long-term potentiation like (LTP-like) effects
- Low-frequency RSS (LF-RSS): 1 Hz frequency, long-term depression like (LTD-like) effects

*Beste and Dinse, 2013*
• HF-RSS leads to improvement in object recognition and hand motor function (nine-hole pegboard test, repetitive finger tapping) in healthy elderly subjects and stroke patients.
Background

- HF-RSS leads to enhancement of intracortical inhibitory mechanisms within S1
- This is paralleled by increased inhibition in M1 as tested with short intracortical inhibition (SICI) paradigm

Rocchi et al., 2017
• Paradoxical effect of HF-RSS applied on the finger skin in idiopathic cervical dystonia: decrease in PP-SEP suppression, HFO area and SICI
• Altered homeostatic plasticity in dystonia?
• Would reversal of effects also occur with LF-RSS?
Background

- LF-RSS applied on the finger skin in idiopathic cervical dystonia increases PP-SEP suppression, HFO area and SICI.
- Could LF-RSS be used to ameliorate dystonia?
- So far, RSS applied on a body part not affected by dystonia.

Erro et al., 2021
Decreased inhibition, possible worsening of dystonia

Increased inhibition, possible improvement of dystonia

Further increase in inhibition due to LTD-like mechanisms following the principle of spike-timing dependent plasticity
Project outline

Three groups of 15 patients with focal hand dystonia, (HF-RSS, synchronous LF-RSS, asynchronous LF-RSS)

Arm Dystonia Disability Scale (ADDS), Unified Dystonia Rating Scale (UDRS)
SEP from muscle stimulation (paired-pulse, dual site, HFO)
Short intracortical inhibition via transcranial magnetic stimulation
Surface electromyography

45-minute stimulation
(either HF-RSS, synchronous LF-RSS or asynchronous LF-RSS)

SEP from muscle stimulation (paired-pulse, dual site, HFO)
Short intracortical inhibition via transcranial magnetic stimulation
Surface electromyography