ered by the online correction method. Fig. 2 shows the same time window of all corrected signals (compare the ECG signals and time stamps of (Figs.1 and 2). Blinksing eyes artifacts, DC shifts of frontopolar signals as well as alpha-EEG are clearly visible in the EEG signals during eyes-closed condition. All signal parts which are phase-synchronized to the 10 Hz sinusoidal stimulation will be eliminated by the correction procedure. However, alpha-waves are still visible in T4, Pz, O1 and O2.

Conclusions: Artifacts in EEG signals during single-channel tES can be easily corrected using reference signals from the tES device. This new method was implemented into neurConn’s tES-EEG products.

Figs. 1 and 2.

References


P 216. Impairment of triad conditioned facilitation in amyotrophic lateral sclerosis—S. Groiss a, b, H. Mochizuki a, c, S. Nakatani-Enomoto a, K. Otani a, Y. Ugawa a ( a Fukushima Medical University, Neurology, Fukushima, Japan, b Heinrich-Heine University, Neurology/Clinical Neuroscience, Düsseldorf, Japan, c University of Miyazaki, Neurology, Miyazaki, Japan, d Fukushima Medical University, Orthopedic Surgery, Fukushima, Japan)

Introduction: Triad conditioned facilitation induced by transcranial magnetic stimulation (TMS) in healthy individuals has been proposed to reflect the intrinsic 40 Hz piper rhythm of the motor cortex. However, it is unclear if triad conditioned facilitation is influenced by degeneration of the motor cortex.

Objective: Amyotrophic lateral sclerosis (ALS) is characterized among others by degeneration of the motor cortex. We therefore hypothesized that triad conditioned facilitation may be impaired in ALS patients. Moreover, we hypothesized that this triad conditioning paradigm may be helpful to differentiate ALS from cervical myelopathy, an important differential diagnosis.

Material and methods: In 10 patients with ALS and 9 patients with cervical myelopathy serving as disease control, we compared single pulse conditioned intracortical inhibition (ICI), intracortical facilitation (ICF) and also triad conditioned facilitation at various interstimulus intervals (ISI) between 3 ms and 50 ms.

Results: There were no differences in ICI and ICF between both groups. Both groups also showed similar triad conditioned facilitation at 10 ms ISI. Patients with cervical myelopathy showed normal triad conditioned facilitation at 25 ms ISI comparable to healthy subjects. In contrast ALS patients showed no triad conditioned facilitation at 25 ms.

Conclusion: The absence of triad conditioned facilitation at 25 ms ISI in ALS patients may represent changes of the intrinsic rhythm of the motor cortex probably caused by cortical degeneration. Triad conditioned TMS may be a valuable tool to differentiate ALS patients from patients with cervical myelopathy.


Introduction: Transcranial magnetic stimulation (TMS) is a valuable non-invasive method for investigation functional changes of the motor cortex after stroke (Groppa et al., 2012; Hendricks et al., 2003; Nascimbeni et al., 2006).

Objectives: The purpose of this study was to assess the excitability of the motor cortex of affected hemisphere (AH) and unaffected hemisphere (UH) in patients with stroke.

Materials and methods: The study involved 48 patients with cerebral hemispheric ischemic stroke in subacute period (mean age-66, 15 ± 1.53 years). Single-pulse TMS was performed to evaluate motor evoked potential (MEP) and resting motor threshold (rMT) with figure-of-eight coil Cool-B65 connected to magnetic stimulator MagPro R100 (Medtronic A/S, Denmark).

Results: The MEP from AH was not obtained even with facilitation in 27.08% patients. The MEP from AH was registered with facilitation in 16.67% patients. The significantly smaller MEP amplitude and the significantly higher rMT elicited from AH than that of MEP amplitude and rMT elicited from UH were observed in 31.25% patients. Only the significantly higher rMT elicited from AH than that of rMT elicited from UH was occurred in 25% patients. Based on TMS results it is useful to distinguish four degrees of reducing excitability of the motor cortex of AH of post-stroke patients: rough, severe, moderate and mild.

Conclusion: MEP and rMT are informative criteria for defining the functional state of the motor cortex and features of cortical reorganization after stroke. The graduation of reducing excitability of the motor cortex of AH is proposed for use in clinical practice and could be considered in evaluation the prognosis after stroke.

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References


P 218. Optimized small animal transcranial magnetic stimulators using distributed coils—G. Crevecour, N. De Geeter, L. Dupré (Ghent University, Electrical Energy, Systems and Automation, Ghent, Belgium)

Question: The precise impact of TMS on the neural pathways and the mechanisms of action remain unknown. Performing studies of different coil configurations in human beings is restricted due to ethical reasons and it is difficult to gather statistically significant data of large human study groups. Therefore, to explore TMS in a systematic and flexible way, miniaturization of TMS for rodent brain studies is a complementary addition to the human studies. Current stimulators for small animal studies lack a high degree of focus of electric field. More optimal designs are thus needed.

References


Methods: We aim at numerically optimizing a distributed planar coil array that can generate a focal electric field in rodent brains. The distributed coil array consists of $N \times N$ coils distributed in a rectangular grid (34 mm $\times$ 34 mm). Since it is practically difficult to activate each coil with a different current, we aim at the activation of the coil array with a single current by placing the different coils in series connection. Since only a single current is flowing through the coil array, the geometrical configuration, e.g. radii and number of turns, of the different coils needs to be optimized. The numerical optimization is performed using a genetic algorithm (Crevecœur et al., 2010) on the basis of the calculated electric fields. The electric fields are calculated starting from the magnetic fields. Further details on the electrical field solver can be found in (De Geeter et al., 2012). The rat head is modeled as four concentric ellipsoids representing the tissues scalp, bone, cerebrospinal fluid (CSF) and brain. The minor and major axes of the inner layer brain are 14 mm and 28 mm long and the other layers are 1 mm and 2 mm thick near the minor and major axes respectively, similar to the rat’s real dimensions.

Results: We performed simulations onto a rectangular coil array with $N=2$ and $N=4$. We observed that $N=2$ yields a limited amount of degrees of freedom so to excite a focal volume of high electric field. $N>4$ is practically very difficult to implement because the radii of the coils would become too small. The optimal spatial electric field distribution in the sagittal plane is given in the figure here below for the $N=4$ distributed coil array (right). As a comparison, a non-optimized electric field distribution (left) is also given, illustrating the impact of the coil configuration parameters. In this configuration we fixed the outer radii of the coils to be 4 mm, so that the coils can be placed within the rectangular grid, as well as the current direction in the different coils. The current directions were chosen similar to the current directions in the figure-8 coils. The optimization parameters were here the number of turns. About 500 genetic algorithm generations were needed for the optimization which resulted in approximately 8 h computation time.

Conclusions: An optimized small animal TMS is presented that enables focal stimulation by activating localized high electric fields. Simulations were performed on a simplified rat model and can be extended towards more realistic head models of rats. Moreover, the degrees of freedom in the design can be extended by including unknown radii of the coils. The numerically designed TMS can be deployed for further in-depth in vivo studies that evaluate the impact of stimulation using neuro-imaging techniques.

References


Stroke is one of the most disabling diseases of the nervous system. Search for new approaches to stroke rehabilitation is an important clinical challenge. Among several noninvasive brain stimulation techniques repetitive transcranial magnetic stimulation (rTMS) demonstrated beneficial effect for motor recovery after stroke. Now there are two main therapeutic strategies of brain stimulation for motor rehabilitation in stroke patients: up-regulation of excitability of the primary motor cortex (M1) of the affected hemisphere (HS) with high-frequency stimulation and/or inhibition of the M1 of the unaffected HS with low-frequency stimulation. The transcranial magnetic stimulation with MRI navigation (nTMS) permits to take into account individual brain anatomy and to repeat stimulation focally. So, we supposed that for rTMS of the primary motor areas for stroke rehabilitation neuronavigation also may improve the results. The randomized blind sham-controlled study of repetitive navigated TMS of primary motor cortex for motor stroke rehabilitation was started.

Design: We plan to include 100 patients in this research. Primary Outcome Measures: evidence of clinically definite ischemic stroke confirmed by CT or MRI; emergence of epileptic seizures. Secondary Outcome Measures: evaluation of the clinical condition of the patients. Clinical condition of patients including motor deficit was assessed with a battery of scales: Fugl-Meyer scale, Ashworth scale, Perry scale, test with 10 meters walking, Bartel index, Renkin scale. Patients were randomly assigned to one of the four groups in the study: 1. Experimental: Low-frequency: 1 Hz, 100% Motor threshold (MO), 20 min, unaffected hemisphere. 2. Experimental: High frequency stimulation: 10 Hz, 80% MT, 2 s-stimulation, 58 s-rest-8 session; affected hemisphere. 3. Experimental: Both hemispheric stimulation: low-frequency to unaffected hemisphere than high-frequency to affect hemisphere. 4. Sham stimulation group: standard treatment and sham transcranial magnetic stimulation. Patients were not aware of the stimulation regimen.

Inclusion Criteria: stroke from 8 days to 3 years in a pool of carotid arteries. NIHSS from 5 to 20 points. Rankin scale at most 3. Exclusion Criteria: implanted pacemaker, intracardiac catheters, electronic pumps, pregnancy or possibility of pregnancy in women of reproductive age; presence of metallic elements or implants in the head region; epilepsy or seizures in anamnesis. It has been recruited 15 patients until now: 3 patients in the sham group; 6 patients in the first group and 6 in the second experimental group. Mean age was 56.6 ± 9.7 years.

Results: Headache appeared at 5 patients after stimulation which held itself. Four patients had an increase of epileptiform discharges on EEG after 10 sessions. Secondary generalized epileptic seizure occurred in 1 patient during single pulse diagnostic TMS (3 months after the stroke in the middle cerebral artery region). Preliminary results show the relief of the post-stroke spasticity and pain after high-frequency stimulation of the affected M1. Motor improvement was demonstrated for low-frequency stimulation of the unaffected M1.

Conclusion: Repeated nTMS is safe and effective add-method in motor post-stroke rehabilitation, but continuous study and forming protocols are necessary to validate this method.

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P 220. Why do we need methods for removing artifacts from TMS-evoked EEG data?—J.C. Hernandez-Pavon, J. Metsomaa, M. Stenroos, J. Sarvas, R. Ilmoniemi (Aalto University, Department of Biomedical Engineering and Computational Science, Espoo, Finland, BioMag Laboratory, HUS Medical Imaging Center, Helsinki University Central Hospital, Helsinki, Finland)

Transcranial magnetic stimulation (TMS) combined with electroencephalography (EEG) is a powerful tool for studying cortical excitability and connectivity. In this study, TMS-EEG is used to study different brain areas. Despite the fact that there are many ways to reduce the artifacts from the EEG signals, it is still very challenging