【国際セッション】

Influence of motor cortex control on reflex stimulating postural tasks

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Introduction

Compensation of postural disturbances plays an important role in daily life as well as in sports activities. However, not much is known about the neuronal structures which are responsible to maintain equilibrium. In the following, methods are introduced that can be applied to identify corticospinal excitability: H-reflex-stimulation is a well-accepted tool to assess motoneuron excitability on the spinal level. In order to make statements about cortical influence on motoneuron output, transcranial magnetic stimulation has proven to be an adequate instrument. Combined application of both, peripheral and transcranial magnetic stimulation (H-reflex conditioning) can offer new insights about the contribution of specific pathways being involved in control of functional motor commands.

Methods

Neuromuscular control is studied while performing a functionally relevant movement: Subjects stand on a moveable platform which is accelerated with 6G in posterior direction. Displacement is 15 cm. To maintain upright position, subjects show short (M1), medium (M2) and long latency reflexes (M3). Transcranial and peripheral nerve stimulation are timed so that both, the MEP and soleus H-reflex arrive in the M. soleus at the same time as the short (M1), medium (M2) or long-latency reflex (M3).

Furthermore, the effect of transcranial magnetic stimulation on the soleus H-reflex (test reflex) during the translatory perturbation is assessed at (M1), (M2), and (M3). To ensure the same level of sensitivity of the test reflex to facilitation, the H-reflex is adjusted to 15-25% of M_{max} (Crone et al., 1990). In order to detect the right interstimulus interval, both, TMS and H-reflex-stimulation are applied with different interstimulus times during walking. Negative interstimulus intervals indicate that the H-reflex precedes the TMS. While walking, subliminal TMS evokes large short-latency facilitations of the test reflex (onset at test interval -5 to -1ms). The first observable facilitation can be attributed to activation of the direct corticomotoneuronal cells in the motor cortex (Petersen et al., 1998).

Statistical significance of differences in EMG with and without stimulating influence was determined by Student-t-tests (two-tailed, 0.05 level of significance; ☆ $p < 0.05$; ☆☆ $p < 0.01$; ☆☆☆ $p < 0.001$).

Results

Subliminal TMS has no influence on M1 ($p > 0.1$) whereas M2 and M3 are significantly increased ($p < 0.000$; Fig. 1). Very similar results can be observed regarding the H-reflex-conditioning. Test-H-reflex at M1 is not altered ($p > 0.05$) in contrast to facilitations in test-reflex size at M2 and M3 ($p = 0.001$ and $p < 0.000$; Fig. 2).

Fig. 1: EMG during perturbation at M1, M2 and M3 with TMS△ and without stimulation ■.

Fig. 2: H-reflex conditioning with TMS at M1, M2 and M3. Conditioned H-reflexes are expressed in % of the control H-reflex.

Discussion/Conclusion

Transcranial pulses influence significantly medium and long latency components of the postural reflex response. With this new methodological approach, it is possible to assess the excitability of the motor cortex in a given task. Based on our results it is reasonable to state that the motor cortex is involved in the compensation of postural disturbances. The facilitatory effect of TMS on the test-H-reflex at M2 and M3 demonstrates the involvement of direct monosynaptic corticomotoneuronal projections in retaining balance. These results suggest that the motor cortex plays an important role not only in controlling complex voluntary movements but also in postural tasks.

References

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