

Cortical Excitability Changes after repetitive thumb training, a TMS study in stroke patients and healthy subjects

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Introduction

Transcranial magnetic stimulation (TMS) is a valuable tool to investigate changes in cortical excitability. TMS has been used to demonstrate that a single session of repetitive thumb training can induce short-lasting changes in cortical excitability and movement kinematics. It has been speculated that these short-term changes in excitability may reflect the first step in acquisition of new motor skills. The aim of the present study was to compare excitability changes in motor cortex after 15 minutes of repetitive thumb movements in stroke patients with healthy subjects.

Methods

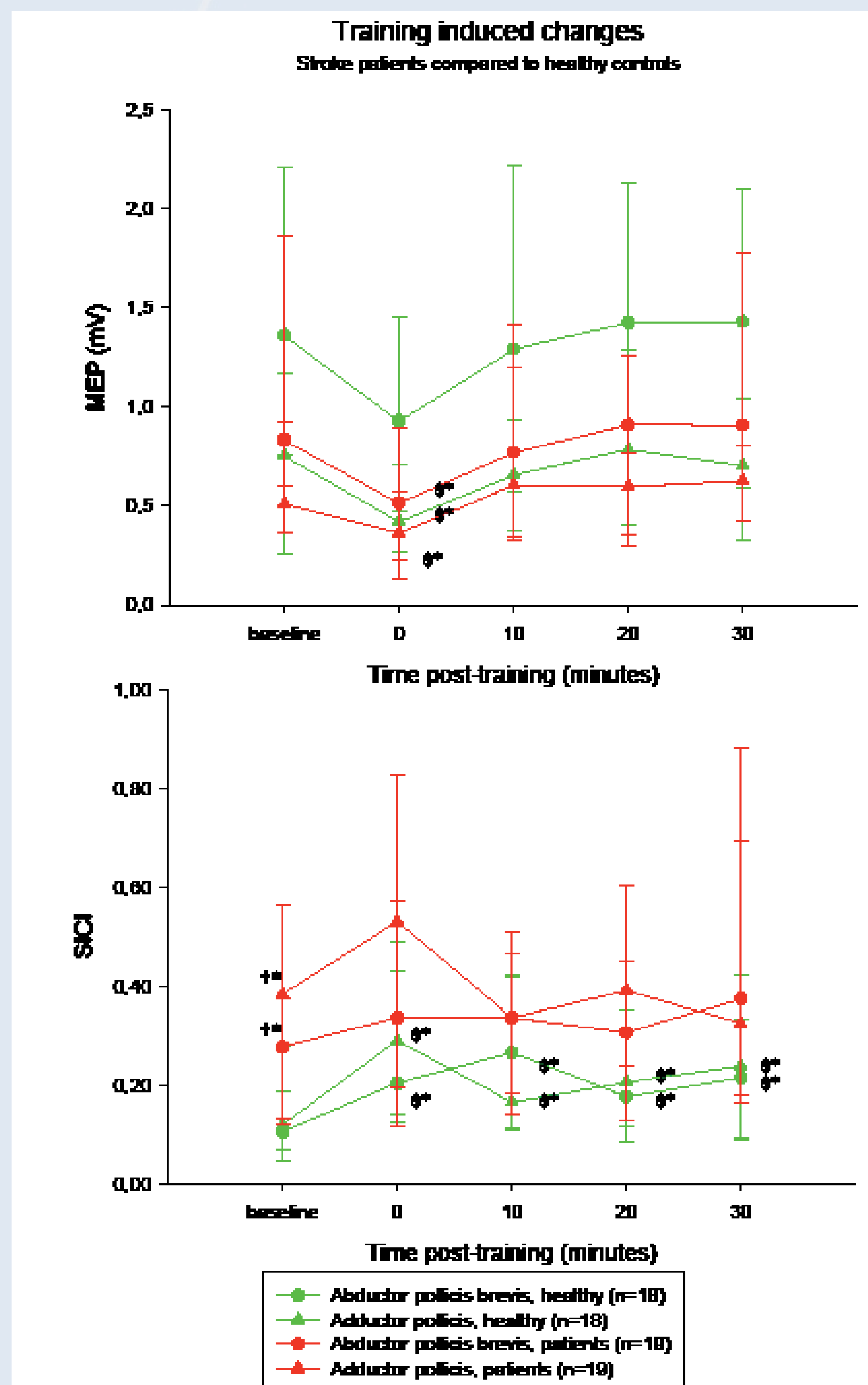
A total of 19 well recovered stroke patients participated. Patients were examined at 6-26 months after either hemorrhagic (2) or ischemic infarction (17). As control 18 healthy age and gender matched subjects were included.

Each participant completed 15 minutes of 1 Hz repetitive adduction/abduction movements of the thumb. During training auditory feedback was given of the EMG activity in the fourth dorsal interosseus muscle (4DIO), participants were instructed to relax this muscle as much as possible during training.

The effect of training was evaluated by TMS. Motor evoked potentials (MEP) were recorded from the abductor pollicis brevis (APB), adductor pollicis (AP), and 4DIO muscles. The stimulation coil was placed over the optimal site to elicit a MEP from APB.

Short-interval intracortical inhibition (SICI) and intracortical facilitation (ICF) were measured in the relaxed muscle by paired pulse stimulation. SICI and ICF were determined as the relation between the size of the conditioned MEP (cMEP) and the uMEP at each time point.

TMS was performed before training and 0, 10, 20, and 30 minutes after.



† Baseline SICI of patients compared to healthy subjects
 \$ Baseline and post-training values compared
 * P<0.05

Results

Baseline

At baseline single pulse MEP was comparable between the two groups, but the intracortical inhibition in the thumb muscles were significantly smaller in stroke patients than in healthy subjects ($P<0.05$). SICI values for healthy subjects were 0.10 (range 0.02-1.2) in APB and 0.12 (0.02-0.88) in AP, in the patient group the values were 0.29 (0.08-1.03) and 0.40 (0.05-1.74) respectively (Figure 1 bottom).

Training effect

Training led to a short-lasting drop in single pulse MEP from the trained thumb muscles in both groups, although the change did not reach significance in APB in the group of healthy subjects ($P=0.06$). The MEP size returned to baseline 10 minutes after training (Figure 1 top).

No change was seen in the relaxed 4DIO ($P>0.05$).

Paired pulse stimulation

In healthy subjects training resulted in a significant decline in intracortical inhibition and consequently a rise in SICI from 0.10 to 0.20 in APB and from 0.12 to 0.29 in AP ($P<0.001$ for both). SICI values remained high for 30 minutes post training (Figure 1b).

In stroke patients no significant change in SICI values was seen, although a SICI did increase slightly in the trained muscles. Neither group showed significant difference in between pre- and post training measures of SICI from 4DIO ($P>0.05$).

References

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Conclusion

Baseline comparison of well recovered stroke patients and healthy subjects showed a significant decline in intracortical inhibition in the patient group. This confirms previous reports on decreased inhibition in the acute stage of stroke, but contrasts beliefs in a normalization in the chronic stage(1). The decline in inhibition can be explained by either a selective loss of GABA neurons after ischemia as proposed by Yamauchi(2). Another possibility is that the decrease in inhibition is a compensatory mechanism related to recovery(3). From animal experiments it is known that decreasing GABA activity unmasks preexisting lateral connections(4). Also a single dose of the GABA_A agonist Midazolam can reinstate stroke symptoms in recovered stroke patients(5). This supports the notion that a persistent disinhibition is beneficial in recovered stroke patients. From previous studies in healthy subjects it is believed that motor training results in a decrease in GABA activity, this has been supported by data from both TMS and MR spectroscopy studies. Our results confirm that intracortical inhibition is decreased after repetitive hand training and that this is only related to the trained muscles. In the patient group, however, no significant change in inhibition is seen, we suspect that this might be explained by the baseline disinhibition. In the patient group the disinhibition might already have reached its limit at baseline, and thus training is unable to induce further changes.