

# AGE-DEPENDENT CLINICAL RESULTS OF EMG-TRIGGERED ELECTROSTIMULATION IN THE TREATMENT OF STROKE PATIENTS

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## Abstract

EMG-triggered electrotherapy is able to reduce spasticity and to increase voluntary muscle force, thus showing a significant improvement of life quality and well-being. The present study was performed in stroke patients to evaluate possible age-dependencies in the clinical outcome of this therapy. A series of 61 indoor stroke patients (31-79 years) were treated with an observation time of 6-10 weeks. EMG-triggered electrotherapy was performed 7-10 times a week. Patients were divided into three groups (I:  $\leq 50$ ys; II: 51-70ys; III:  $\geq 71$ ys). Spasticity was reduced in each group (pendulum test and modified Ashworth-scale), showing a significantly better improvement I vs. II ( $p \leq 0.01$ ) and II vs. III ( $p \leq 0.005$ ). There was a higher increase of muscle contraction force (hand-held myometer) in the younger groups (I+II vs. III,  $p \leq 0.002$ ). There was also a better improvement in the abilities of daily living and life quality (I vs. II  $p \leq 0.005$ , and II vs. III  $p \leq 0.005$ ). EMG-triggered electrostimulation in stroke patients is more effective in younger patients than in elderly people.

## Introduction/Background

Low frequency electrostimulation, triggered by electromyographically measurable voluntary muscular activity (EMG-triggered electrotherapy) is able to reduce spasticity and to increase voluntary muscle contraction force, and this kind of therapy is superior to conventional electrotherapy as well as to physiotherapy alone. Additionally, it shows a significant improvement of life quality and well-being. One of the first publications on this topic was Hansen's paper from 1979 (1), a review paper has been published by the GESET working group in 1999 (2), including studies of our own group (3,4). Previous investigations have found that even patients with a stroke history of more than one year may profit of EMG-triggered electrotherapy (5). Usually, this kind of therapy has some positive effect even in elderly people, with the clinical impression that elderly people may react somehow less or in a slower

time course. Thus, the present study was performed in stroke patients to evaluate possible age-dependencies of the clinical outcome.

## Methods

A series of 61 indoor (ischemic) stroke patients with incomplete spastic hemiparesis (31-79 years, left hemisphere: N=29, right hemisphere: N=32) were treated for  $8.2 \pm 1.5$  (6-10) weeks. Additionally to physiotherapy, EMG-triggered electrotherapy was performed 7-10 times a week using conventional devices, industrially provided by several German companies (see acknowledgment). The stimulation was performed in therapeutical sessions with a duration of 30 minutes each. Stimulation intensity varied, always resulting in a good contraction without causing any pain. During one session, the forearm extensor muscles, which are antagonistic to the spasticity pattern, were trained by the patient using his own voluntary muscular activity to trigger the stimulation device by voluntarily lifting his hand and his fingers. Including the breaks which were necessary for the patient's relaxation, recreation and concentration, during one session 50 stimulations were performed on average. Patients were divided into three groups (Group I:  $\leq 50$ ys, N=13; group II: 51-70ys, N=29; group III:  $\geq 71$ ys, N=19). Spasticity was evaluated using the pendulum test of the arm (3) and the modified Ashworth-scale. Muscle contraction force was measured with a hand-held myometer (Penny & Giles, Christchurch), measuring the force of extensor as well as flexor muscles. The abilities of daily living (ADL) were evaluated using the Barthel index and the Functional Independence Measure (FIM), life quality was estimated using von Zerssen's well-being scale (Bf-S, a self rating scale) and additionally by a visual analogue scale.

## Results

Spasticity:

Spasticity was reduced in each of the three groups. This

was an overall and general effect and was not restricted to the muscle groups as stimulated. The pendulum test of the arm, resulting from the behaviour as well of flexor as of extensor muscles (normal range  $1.6 \pm 0.4$ ) showed an increase of 0.70 to 0.99 in group I, of 0.72 to 0.91 in group II and of 0.72 to 0.82 in group III, showing a significantly better improvement in group I vs. group II ( $p \leq 0.01$ ) and II vs. III ( $p \leq 0.005$ ). The modified Ashworth-scale showed a decrease of 7.1 to 3.8 in group I, 7.2 to 4.2 in II and 6.9 to 4.9 in III, showing a significantly better improvement in group I vs. group II ( $p \leq 0.01$ ) and II vs. III ( $p \leq 0.01$ ).

#### Muscular contraction force:

The contraction force of the stimulated muscle groups (hand- and finger extensors) increased as well as the force of the antagonistic flexors. There was a higher increase of contraction force in the younger groups with no significant differences between group I and II, but I+II vs. III,  $p \leq 0.002$  when evaluating the tetanic extension force of the hand (increase of  $5.4 \pm 1.0$  kp vs.  $2.6 \pm 1.9$  kp) and  $p \leq 0.01$  when evaluating the tetanic extension force of the forearm (increase of  $4.3 \pm 1.1$  kp vs.  $2.8 \pm 1.1$  kp).

#### Abilities of daily living:

There was also a better improvement in the abilities of daily living using the Barthel index with an increase of the overall score of  $30 \pm 11$  in group I,  $25 \pm 8$  in group II and  $15 \pm 12$  in group III (I vs. II  $p \leq 0.005$ , and II vs. III  $p \leq 0.005$ ) and the FIM (I vs. II  $p \leq 0.01$ , and II vs. III  $p \leq 0.005$ ).

#### Life quality:

According to their ADL-improvement, younger patients stated a better improvement of their life quality (Bf-S-well-being-Scale:  $-20 \pm 8$  in group I,  $-15 \pm 4$  in group II and  $-5 \pm 4$  in group III (I vs. II  $p \leq 0.01$ , and II vs. III  $p \leq 0.01$ ).

## Discussion/Conclusions

According to extensive own clinical experiences in more than 500 patients and to a large number of studies that have been published during the last 20 years, including studies of our own group (3), EMG-triggered electrostimulation can be recommended as a valuable tool in the rehabilitation of stroke patients. The results of the present study are able to confirm these previous studies. Additionally they indicate a time dependency of the clinical outcome to the patient's age. Patients

younger than 50 years show a greater improvement on each level of investigation than elderly people do. The decrease of spasticity, the increase of voluntary muscle contraction force, the improvement of their abilities of daily living and their well-being is significantly better than in elderly patients. Younger stroke patients seem to have a greater cerebral capacity of regulation and regeneration, indicating a greater plasticity of the brain tissue and the neuronal network (6), additionally, we know a particular lesion-induced plasticity from the animal experiment (7). However, it is possible that the better results of the younger patients only mean that they react earlier than elderly patients, and not necessarily better. Thus, the clinical meaning and therapeutical consequence of these findings are that an indication for this kind of therapy has to be given independently of the patients age, as elderly patients had a similar profit. To decide whether elderly stroke patients have the same chances for clinical improvement and only need a longer time of therapy, a follow-up study now is planned to investigate the velocity of the time course of the clinical improvement with EMG-triggered electrostimulation in elderly stroke patients during an observation period of 6 months.

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