



## The effects of therapy on spasticity utilizing a motorized exercise-cycle

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F-wave amplitudes have been used to demonstrate changes of motor neuron excitability in patients receiving pharmacological antispastic therapy as well as in those having physiotherapy. In this study it is shown that F-wave amplitudes can also be used to document changes of motor neuron excitability as an effect of the therapy with a motorized exercise-cycle, which moves the legs of paraplegic patients in a way similar to cycling. Ten F-waves were recorded immediately before and after the therapy with a motorized exercise-cycle in 70 legs of 35 patients with spastic paraparesis. Mean F-wave amplitude, mean F-wave/M-response ratio and maximum F-wave/M-response ratio were significantly lower after therapy than before. Conclusion: The antispastic effect of the therapy with a motorized exercise-cycle may be documented by a decrease of F-wave-amplitude parameters.

**Keywords:** spastic paraplegia; physical therapy; exercise-cycle; electrophysiology; F-waves

### Introduction

F-wave size has been shown to reflect changes of motor neuron excitability.<sup>1</sup> Several authors found that it is increased in those with spasticity.<sup>2-8</sup> But it is also somewhat increased in healthy subjects when obtained after stimulation with frequencies above 0.2 Hz.<sup>4</sup> Therefore F-wave studies to evaluate antispastic therapeutic effects should be performed at a stimulation rate not higher than 0.2 Hz.

The F-wave amplitude changed parallel to the muscle tone after an acute cerebral insult<sup>3</sup> and was reduced by several medicines in long standing post-stroke hemiparesis.<sup>5,9</sup> Intrathecal Baclofen reduced the mean F-wave amplitude even about 60%.<sup>10</sup> But physiotherapy was also shown to reduce the F-wave-amplitude.<sup>11</sup> In spastic hemiparesis following a stroke T-, H-reflex-amplitude ratios as well as F-wave amplitude ratios were increased. But only the F-wave amplitude ratios decreased after treatment.<sup>5</sup> The F-wave/M-response ratio was also shown to correlate with the increase of muscle tone in patients with multiple sclerosis.<sup>12</sup> It was more sensitive to changes of lower motoneuron excitability induced by physiotherapy than the F-wave-amplitude itself.<sup>11</sup>

Physiotherapy plays an important part in the rehabilitation of patients with spasticity. But since qualified physiotherapy is not available every day for patients living at home, therapy with a motorized exercise-cycle is often necessary to treat spasticity in

people with multiple sclerosis.<sup>13</sup> The aim of this work is to investigate whether the effects of antispastic treatment with a motorized exercise-cycle can be documented by F-wave-amplitude parameters.

### Materials and methods

We examined 35 patients with spastic paraparesis; 31 had multiple sclerosis, one had multiple system atrophy and two patients had familial spastic paraplegia. In the remaining patient a spinal tumor was detected. Their age ranged from 32 to 67 years (Mean 49; SD 10.32). Duration of disease ranged from 7 to 39 years (Mean 15.92; SD 9.12). All had increased muscle tone, decreased muscle force and positive Babinski signs.

Electrophysiological examination was performed with the 'Toennies Multiliner' immediately before and after a treatment with a motorized exercise-cycle. Electrophysiological examination and treatment were performed in the same room. The patients were tested in the supine position and were encouraged to relax as much as possible. M-response was recorded after surface electrode supramaximal electrostimulation of the tibial nerves at their distal points from the flexor hallucis brevis muscles. Then 10 F-waves were recorded after supramaximal electrostimulation at a rate of 0.2 s. The whole procedure was performed on each leg before and after treatment. The shortest F-wave-latency, M-response-amplitude and F-wave-amplitudes were registered for evaluation. All parameters before and after treatment were compared with the Wilcoxon paired test.

Physical therapy was performed using MOTomed<sup>R</sup>, which is a motorized exercise-cycle for the reduction of spasticity by rhythmical movement of the legs. In this study treatment was performed for 30 min with a speed of 40 rounds per minute.

### Results

The amplitude of the M-response was 17.3 mV (SD 8.16) before and 17.44 mV (SD 8.07) after the treatment with a motorized exercise-cycle. In 38 legs the amplitude of the M-response increased (n sign). The shortest F-wave-latencies were 50.2 msec (SD 3.73) before and 50.5 msec (SD 3.95) after the treatment with the motorized exercise-cycle. In 36 legs the latencies increased (n sign). Thus there was neither a significant change in F-wave-latencies nor in M-response-amplitudes. The mean of F-wave-amplitudes was 0.62 mV (SD 0.41; SEM 0.049) before and 0.56 mV (SD 0.35; SEM 0.041) after treatment. In 42 legs the mean of F-wave-amplitudes decreased ( $P < 0.05$ ). The maximum of F-wave amplitudes was 0.95 mV (SD 0.53; SEM 0.063) before and 0.86 mV (SD 0.46; SEM 0.055) after treatment. In 44 legs the maximum of F-wave-amplitudes decreased, but the decrease failed to reach significance ( $0.05 < P < 0.1$ ). Thus there was a slight significant decrease of mean amplitudes after treatment with the motorized exercise-cycle when only the F-waves were considered. But the decrease was clearly significant when the relation of F-waves to the M-responses was taken into account (Figure 1). The Mean-F-wave/M-response ratio was 4.23% (SD 3.06; SEM 0.37) before and 3.72% (SD 2.38, SEM 0.28) after treatment.

The mean-F-wave/M-response ratio decreased in 47 legs ( $P < 0.001$ ). The maximum-F-wave/M-response ratio was 6.71% (SD 5.3; SEM 0.63) before, and 5.89%: (SD 4.24; SEM 0.51) after treatment. Maximum-F-wave/M-response ratio decreased in 45 legs ( $P < 0.02$ ). Thus both F-wave-M-response ratios were lower after but not before the treatment with the motorized exercise-cycle. In 16 legs none of the four F-wave-amplitude parameters taken into consideration decreased. But in only two patients was there no decrease of F-wave-amplitude parameters in both legs.

### Discussion

Normal values for F-wave amplitudes were published by Fisher *et al.*<sup>14</sup> They found a mean value for the mean F-wave/M-response ratio of 2.2% (SD 0.7; range 1.2–3.5%). In comparison to their values the mean F-wave/M-response ratio in our patients was clearly increased before and still somewhat subsequent to treatment with a motorized exercise-cycle.

Milanov<sup>6</sup> hypothesized that alpha-neuron-excitability, as measured by F-wave-amplitudes, usually

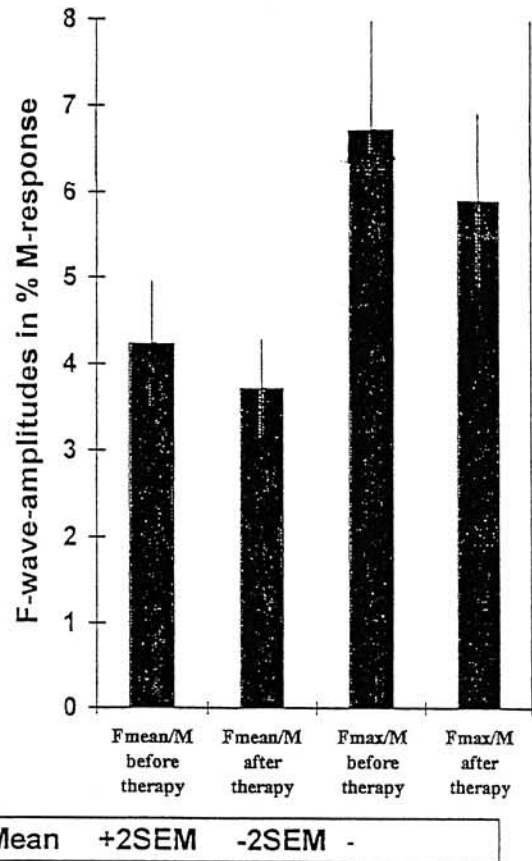


Figure 1 Changes of F-wave/M-response ratio after 30 min treatment with a motorized exercise-cycle

develops secondarily after alteration of some other segmental mechanism in those with spasticity (eg: increased gamma-motoneurone activity, altered interneurone activity, decreased presynaptic inhibition). Therefore several different mechanisms may have led to the high F-wave-amplitudes observed in this study. Not all of them may have been influenced by the treatment with a motorized exercise-cycle. In addition secondary changes in the muscles may occur. This may be the reason for the decrease of F-wave-amplitude/M-response ratio after the treatment with a motorized exercise-cycle not being observed in every treated leg. Since F-wave/M-response ratios proved to be more significant to changes of motoneuron excitability than were the raw F-wave-amplitudes, it is clear that an effect on motoneuron-excitability is sometimes only noticed by comparing F-wave/M-response ratios. The antispastic effect of treatment with a motorized exercise-cycle can be documented by recording F-wave-amplitudes.

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154. Effectiveness of anti-spasm treatment of exercises with the MOTOmed, measured with amplitude changes of the F-waves.  
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Amplitude changes of the F-waves have been used several times for the documentation of a success in case of a medicinal anti-spasm therapy. So, it has been possible to give evidence for the anti-spasm success of physiotherapeutic therapy by amplitude changes of the F-waves and especially the amplitude proportion F-wave/M-response has proved to be a sensitive parameter.

The aim of the work in hand is to prove the anti-spasm effectiveness of the treatment with the MOTOmed by changes of the amplitude proportion F-wave/M-response during the therapy.

At 40 legs of 20 patients with marked paraspasm, the M-response and ten F-waves at the M. flexor hallucis brevis in case of supramaximum irritation of the N. tibialis have been measured before and after a treatment of 30 minutes with the MOTOmed.

The electrophysiological treatment has been executed by the „Toennies Multilinef“. The shortest F-wave latency as well as the amplitudes of the F-waves and the M-answer have been evaluated. The statistical comparison has been executed with the Wilcoxon-test for spot checks.

The MOTOmed is a motorized exerciser which moves passively the legs of the patients. But the direction of rotation will be reversed when a spasm occurs by a so-called spasm control.

The amplitude of the M-answer and the shortest F-wave latency have not been changed significantly by the treatment. But the proportion of the average F-wave amplitudes to the amplitudes of the M-answer has been reduced significantly from 4,61 to 4,15 % ( $p < 0,05$ ) and the proportion of the biggest F-wave amplitudes to the amplitude of the M-answer has been reduced significantly as well from 7,45 to 6,65 % ( $p < 0,05$ ).

The raising of the excitability of the  $\alpha$ -motorneurons in case of spasms (measured by the F-wave amplitudes parameters) appears mostly as a consequence of different other mechanisms. Probably, not all of these mechanisms are influenced by the treatment with the MOTOmed. This could be the reason why there has not been a reduction of the proportion of the F-wave amplitudes/M-answer by the treatment of all patients. But the significant reduction of both F-wave amplitude parameters argues in favour of an anti-spasm effectiveness of the treatment with the MOTOmed which can be documented with F-wave examinations.