

Effects of whole-body vibration in rehabilitation of spinal cord injury patients



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ENS Barcelona 2004

1 Introduction

In the literature numerous treatment are described being effective to improve motor control abilities after spinal cord injury (SCI). From a scientific as well as from a patients point of view restoring locomotor capacities is one of the most focused aspects in rehabilitation. A very prominent and well described method is locomotion therapy using a treadmill (WERNIG et al. 1995). Principally stepping movements of the patients can be generated or supported by a physiotherapist or a robot system.

In the last 15 years a couple of mechanisms were discussed for being responsible of achieving motor control improvements after SCI, but finally the underlying mechanisms are poorly understood. However, it is widely accepted that the injury leads to a reorganization of spinal processes on caudal level to the lesion, but it is unclear to which extent it is a result of training or just the consequence of losing supraspinal inputs (Edgerton et al. 2001).

Anyway it is generally believed that afferent input resulting from artificial locomotion or other training devices and mechanical stimulation respectively are key mechanisms in rehabilitation. Even if the exact pattern of sensory stimulation and muscular reactivation is unclear some trends become obvious in literature (Pearson 2001):

- 1) Stimuli should generate muscular reflexes in the leg muscles.
- 2) Stimuli should activate load receptors since they have a strong effect on spinal networks which are fundamentally connected with locomotion (central pattern generator = CPG).
- 3) Stimuli should be generated repeatedly i.e. it should have an oscillating character.

With respect to these recommendations the guiding aim of this study at hand was to analyse the effects of a whole-body-vibration (WBV) treatment in SCI patients. It can be speculated that this treatment might be effective since it is known that WBV leads to stimulate load receptors and reflex activation in the leg muscles frequently (HAAS et al. 2004).

2 Methods

The whole project is based on different experiments. 40 subjects with spinal cord injury (18 paraplegic, 22 tetraplegic patients) participated in the first study. After initial analyses they were subdivided in one experimental and one control group 20 subjects each. The treatment of control group was based on traditional rehabilitation programs for SCI patients like physiotherapy and locomotion therapy. In the experimental group whole-body-vibration – using ZEPITOR[®]-med (ampl. 3 mm, freq. 3-6 Hz) – were applied additionally. Before, during and after the rehabilitation program a complex clinic test battery was performed in order to assess motor control abilities of the patients.

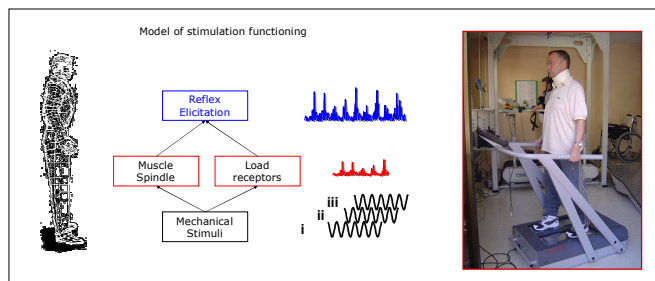


Fig. 1a: Model of stimulation functioning

Fig. 1b: SCI patient performing training on Zeptor[®]

Another single case study focused neuromuscular responses that occur during and after the treatment by the use of electromyography of knee extensors. In order to get information about neuromuscular and cinematic interaction acceleration sensors were fixed at the oscillating platforms. Further more goniometry was performed at the knee.

The patient was treated 3 times each week over a period of 8 weeks. Each training sessions contained 10 series taking 45 seconds each.

3 Results

All patients showed significantly improved motor control abilities after their rehabilitation program. With respect to different treatment strategies patients of the experimental group showed on average better test parameters than control patients. Highly significant group differences were found in gait and balance analyses. Figure 2a shows the results of a minute gait test results. In 2b different postural control performance becomes obvious. Beside these parameters gait pattern shows prominent group differences, too (Fig 3). It should be pointed out that differences increase with the duration of rehabilitation program.

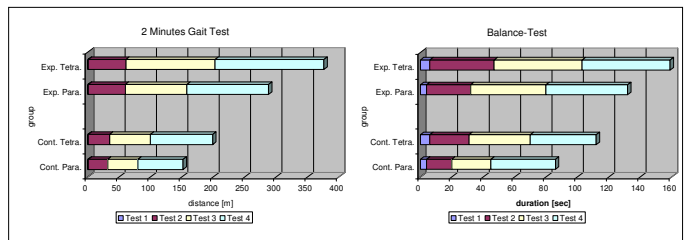


Fig. 2a: Performance in 2 Minutes Gait Test

Fig 2b: Performance in balance Test (Berg-Scale)

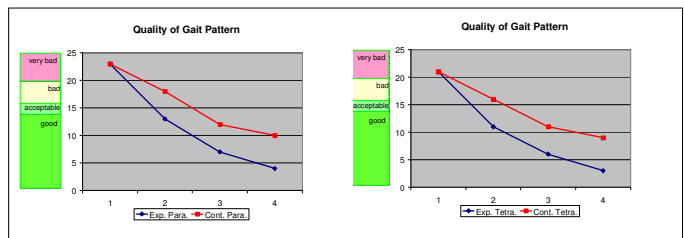


Fig. 3a: Quality of Gait Pattern in paraplegic group

Fig 3b: Quality of Gait Pattern in tetraplegic group

EMG analyses in the single case study showed prominent changes in muscular activation. In the early analyses unsystematic muscular activation pattern were found. After a few training sessions bursts become stronger and highly coupled to knee kinematics and platform movements respectively. This indicates that the patient developed a systematic reflex-pattern which is from a qualitative point of view comparable to healthy subjects.

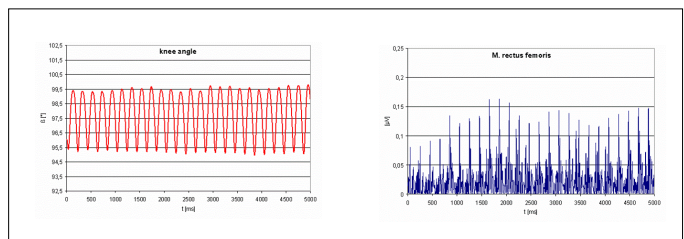


Fig. 4a: Pattern of knee angle changes during treatment

Fig 4b: EMG Pattern of M. rectus femoris during treatment

4 Discussion and Conclusion

The aim of the study was to analyse effects of WBV after SCI in an explorative context. Currently it is not able to compare results of different treatment methods. By ethical reason the study was not placebo-controlled. This might have an impact on the results, too. Anyway, after a general consideration of all findings WBV have to be regarded as an effective treatment in SCI patients. With respect to neurophysiologic mechanisms one can speculate on changes on several levels. Even if the function of central-pattern-generators is not well defined we hypothesize that WBV activates spinal CPG since all key aspects of functional training stimuli described in the literature were taken into account in this treatment.

References:

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