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Functional Electrical Theraphy (FET) for the Training of Gait in Patients with Hemiplegia

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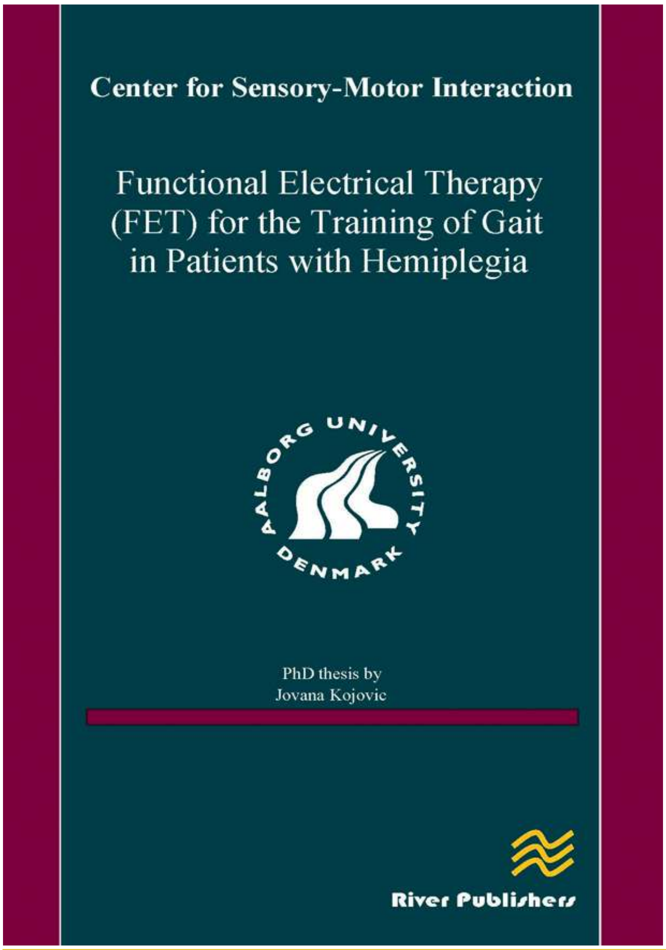
Gait recovery is a major objective in the rehabilitation program for stroke patients. Therefore, for many decades, hemiplegic gait has been the object of study for the development of methods for gait analysis and rehabilitation. In this thesis we introduced new therapeutic method in gait rehabilitation, based on application of sensors driven functional electrical stimulation. The automatic control relates to the timing of stimulation of four muscles. The sensor system comprises accelerometers and force-sensing resistors. The automatic control implements IF-THEN rules designed by mapping of sensors and muscle activation patterns. The evaluation included 13 stroke patients assigned to a FET group or a control (CON) group. Both groups were treated with a standard rehabilitation program and 45 minutes of walking for 5 days over the course of 4 weeks. The difference between the groups was that the FET group received electrical stimulation during walking. The Fugl-Meyer (FM) test for the lower extremities, Barthel Index (BI), walking velocity over a 6-meter distance, and Physiological Cost Index (PCI) were assessed at the beginning and at the end of the treatment. Subjects within the FET and CON groups had comparable baseline outcome measures. In the FET group, we determined significant differences in the mean values of all tested parameters ($p < 0.05$). In the CON group we found significant differences in FM test scores and BI ($p < 0.05$), but the differences in walking velocity and PCI were not significant ($p > 0.05$). We also found a larger increase in mean values of outcome measures in the FET group compared with the CON group (e.g., average velocity increased 60% in the FET group compared to an 11% increase in the CON group). We also present a method for assessing muscle activation patterns during goal-directed movement in a cohort study from a randomized clinical trial ,that followed the recovery of motor function during and after intensive gait training, assisted by sensor-driven, four-channel electrical stimulation. The instrument that we developed allows for the simultaneous recordings of up to 16 channels that are wirelessly sent to a host computer, which then provides feedback to the subject. The inputs connectors to the portable instrument are electromyography (EMG) amplifiers, and include inertial and other sensors. We show that this method is sensitive enough to show changes in muscle activation patterns in stroke patients before and after gait training(four weeks, five days a week, 30 minutes daily). We also show that the recovery decreases the differences between patterns of muscle activities (e.g., levels of muscle activations and median frequencies) assessed in hemiplegic and healthy subjects. This method allows for the analysis of muscle contributions and activation patterns; therefore, it might be possible to better understand the physiology behind the recovery of function. This EMG analysis provides a quantification of recovery that is a valuable addition to other meagait speed, and the symmetry index.



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