

Critical revision of muscular electrical stimulation after 20 years

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In the last 20 years, many studies and efforts have been devoted to realize efficient systems for the recovery of motor functions in spinal cord injured patients. For tetraplegic patients, most of the attentions have been focused on the recovery of respiratory function by proper activation of diaphragm by stimulating the phrenic nerve and for the recovery of arm and hand functions by stimulating selected muscles of the upper limb.

In paraplegic patients, many studies have been focused on complex systems able to restore walking. As human walking is the result of a complex coordination of muscle activity, which is normally accomplished by the Central Nervous System (CNS), most of the studies have considered the mechanisms involved in neuromotor control. The goal has been to implement special mathematical models able to simulate in a proper way the control strategies activated by the CNS. The results from a theoretical point of view obtained by multidisciplinary approaches, promoted also by several international projects sponsored by European Community, have been very promising. In several pilot studies, patients have been implanted with devices with 8 and more channels to activate the main muscles of the lower limbs according to complex programmes adaptable to the single patient. Such systems integrated with proper sensorized orthoses and crutches have allowed in several paraplegic patients to reach a "human like locomotion". In this presentation, such results will be analysed pointing out strengths and weaknesses in order to understand possible future developments on these topics.