

Patologia muscolare nella paraplegia da lesione del motoneurone spinale e recupero funzionale con stimolazione elettrica domiciliare

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Abstract

Muscle pathology in lower motor neuron paraplegia and h-b FES

After complete Spinal Cord Injury (SCI), causing complete disconnection between the muscle fibers and the nervous system, the denervated muscles become unexcitable with commercial electrical stimulators within several months and undergo severe atrophy and disorganization of contractile apparatus after 1-3 years. Years after the injury the surviving and regenerated myofibers are substituted with adipocytes and collagen. To counteract the progressive changes transforming muscle into an unexcitable tissue, we developed a novel therapy concept for paraplegic patients with complete lower motor neuron LMN denervation of the lower extremity. The new stimulators for home-based functional electrical stimulation (h-b FES) have been designed to reverse longstanding and severe atrophy of LMN denervated muscles by delivering high-intensity (up to 2,4 J) and long-duration impulses (up to 150 ms) able to elicit contractions of denervated skeletal muscle fibers in absence of nerve endings. Concurrent to the development of the stimulation equipment, specific clinical assessments and training strategies were developed at the Wilhelminenspital Wien, Austria. Main results of our clinical study on 20 patients which completed a 2 years h-b FES program: 1. significant +33% increase of muscle size and +75% of the mean diameter of muscle fibers, with striking improvements of the ultra-structural organization of contractile material; 2. recovery of the tetanic contractility with significant increase in muscle force output during electrical stimulation; 3. five subjects performed FES-assisted stand-up and stepping-in-place exercises; 4. data from ultrastructural analyses indicating that the shorter the time span between SCI and the beginning of h-b FES, the larger were the number and the size of recovered fibers. The study demonstrates that h-b FES of permanent LMN denervated muscle is an effective home therapy that results in rescue of muscle mass, function and perfusion. Additional important benefits for the patients are the improved cosmetic appearance of lower extremities and the enhanced cushioning effect for seating.

Key Words: skeletal muscle, morphometry, paraplegia, lower motor neuron, FES recovery

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