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Longitudinal feasibility study of a SCI subject one-year training based on sublesional muscles FES assisted cycling

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Introduction

Subjects with spinal cord injuries (SCI) early suffer from immobility and sedentary effects, such as bone demineralization, an increased risk of developing cardio-vascular diseases as well as cutaneous complications like pressure sores. Despite a well established benefit of regular exercise¹ not only on physical health but also on mood, anxiety and social isolation, to suggest a physical activity adapted to SCI daily life efforts is however far from simple. Functional Electrical Stimulation (FES) of sublesional muscles aims to increase oxygen demand therefore contributing to improve cardiovascular and respiratory physiology². Applied through a leisure activity such as cycling could also significantly increase wellness and life quality. In this study we propose an original longitudinal follow-up of physical and psychological variables during a one-year training, with the ultimate goal of participating to an international FES-cycling competition.

Method

In order to design a protocol training to be later tested in an adequate sample of SCI patients, our subject was included without a-priori screening and without taking into account his non optimal individual characteristics: age 47 y.o, complete SCI (AIS A), level T3, with post-lesional duration > 20 years and no stimuable gluteus maximus. During one year, we asked him to follow a FES training protocol based on two stages. One home based, in which the subject followed from month M1 to M6, two to three times a week an isometric stimulation program of his lower limb muscles during 30 min. A second one from M7, in which we asked him to perform a FES-cycling training program, two to three times a week, on an instrumented trike. Either set on a home trainer or rolling outdoor and indoor on a flat surface, we modulated stimulations parameters and monitored physical, psychological and functional variables in order to track different evolutions related to the training program. At M12, our subject participated to a FES-cycling competition where he had to perform the furthest distance within an 8 min race.

Results

Different indicators showed a global acceptance and improvement on both physical performances and psychological tolerances, such as self-worth, and an important increase in life quality. Despite no significant physical and physiological changes have been reported, a decrease in sublesional fat mass was observed and the subject declared an improvement in the shape of his thighs. Speed and endurance goals were successfully reached, as at M12 the subject was able to perform 750 m at 5.8 km/h in less than 8 min in competition conditions and 1080 m in 13 min in training condition.

Discussion and conclusions

Taking part in a competition as the final aim of the training program demonstrated a real benefit on training constraints tolerance. Once an optimal stimulation pattern and a bike configuration were set, functional performances of the patient were constantly increasing. This study break new grounds to innovative FES-cycling based training programs for an important range of SCI subjects.

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2. Hooker SP, Fagoni SF, Rodgers MM, et al. Physiologic effects of electrical stimulation leg cycle exercise training in spinal cord injured persons. Arch Phys Med Rehabil. 1992; 73: 470-6.