Abstract

'Hybrid' functional electrical stimulation (FES) ergometer rowing is a novel training therapy that enables the spinal cord injury (SCI) population to exercise the innervated upper body together with the electrically stimulated lower body muscles. This produces significantly greater aerobic power and peak oxygen consumption than either upper body or FES exercise alone. However, there is minimal information on the mechanical efficiency of FES-rowing in the SCI population. A Concept 2 rowing ergometer was adapted to accommodate SCI patients and was instrumented to record upper body force and lower limbs forces. The current setup allows correlating changes in oxygen consumption with changes in effective muscle forces collected at the feet and handle at three submaximal rowing intensities and during a submaximal bout of rowing to fatigue in SCI and able-bodied rowers. The data suggests that while able-bodied rowers increase legs and arms forces proportional with increased rowing intensity, the SCI rowers use primarily their arms to achieve a higher rowing wattage. FES-rowing has positive effects on cardio-respiratory fitness showing an increase in oxygen consumption; however, we hypothesize that this effect would be greatly enhanced by increasing the mechanical work done by the legs in SCI rowers.

Background

Currently there is no cure for spinal cord injury. There are an estimated 276,000 people living with a SCI in the USA with roughly 32 new SCI patients every day. The SCI population is at the low end of the fitness spectrum with high risk of cardiovascular disease, diabetes, obesity, and osteoporosis. Bone density decreases rapidly in SCI patients to approximately 60% of normal bone mass within one to three years after injury. About 40% of the SCI population experiences fractures in the trabecular-rich sites of the proximal tibia and distal femur. Thus, there is a need for a rehabilitation therapy that will reduce or ameliorate secondary problems caused by SCI. Functional electrical stimulation ergometer rowing is a novel training therapy designed to enable the SCI population to exercise their large muscles of the legs together with the upper limb muscles leading to increased metabolic responses.

This study proposes a full biomechanical analysis of FES rowing that will lead to guidance for the SCI population for an optimal exercise regimen that may attenuate bone loss.

Method

This study proposes a full biomechanical analysis of FES rowing that will lead to guidance for the SCI population for an optimal exercise regimen that may attenuate bone loss.

Conclusion

• The current setup allows acquisition of repeatable data during FES rowing in SCI patients, helping monitor therapy progression and identify optimal rowing techniques.

• Progressive exercise during maximal aerobic capacity tests shows similar lower and upper body forces of 0.7-0.9 BW in able-bodied. However, in SCI population the lower body experiences less than 0.3 BW load during FES-rowing.

• Fatigue rowing at a constant work load during maximal aerobic capacity tests shows a fast decline in lower body force in the first 2 minutes of exercise, compensated by an increase in upper body force in the SCI population.

• Able-bodied are more mechanically and metabolically efficient during rowing than those with SCI.

References