Journal of Clinical & Experimental Cardiology

Banerjee and Ennis, J Clin Exp Cardiolog 2013, 4:2
DOI: 10.4172/2155-9880.1000e120

Editorial

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Electrical Muscle Stimulation for Heart Failure: where do we Stand?

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Chronic heart failure is an expanding epidemic with a poor prognosis. About 30-40% of patients diagnosed with heart failure die within a year [1]. The benefits of exercise rehabilitation in heart failure are well established [2]. Conventional exercise training has been shown to improve abnormalities that occur in the skeletal muscles and peripheral circulation in heart failure independent of any effect on the heart [3]. Training can also improve the neurohormonal status [4] and markers of immunity [5] in these patients. The overall effect is a combined improvement in exercise capacity, quality of life and mortality [6].

Functional electrical stimulation (FES), more commonly known as electrical muscle stimulation (EMS) or neuromuscular electrical stimulation (NMES), offers through initial fitness improvements, a bridge to conventional exercise and rehabilitation [7] or can be regarded a substitute for conventional exercise. EMS involves attaching adhesive gel rubber electrodes to the skin overlying large muscles of the legs, via an electrical cord to a battery operated controller. Electrical currents generated by these battery operated units cause stimulation of motor nerves supplying particular groups of muscles resulting in muscle contraction [7]. EMS used regularly encourages muscle strength, so patients can start to perform more daily activities [8]. At lower frequencies, EMS can also stimulate breathing and the heart rate in a way similar to when engaged in physical exercise, thus providing exercise benefits [8]. The technique appears to be very safe.

In the last ten years, the effectiveness of EMS in CHF patients of mild to moderate severity has been examined. Small early trials found that higher frequency EMS produced improvements in muscle strength and metabolic measures of exercise capacity in highly selected patients around the time of cardiac transplantation [9,10].

Later, investigators altered stimulation protocols to target improvements in aerobic capacity [11-13]. Remarkably, similar improvements in aerobic endurance to conventional exercise were found, randomising patients to either a conventional exercise program or EMS. Nuhr et al. [14] showed that chronic low frequency stimulation induced a shift in the muscle fibre type from fast glycolytic to slow oxidative. Minogue et al. [15] reviewed EMS protocols that measured O_2 uptake and found that higher frequency stimulation normally used for muscle strengthening was not suitable for producing a sustained increase in oxygen uptake. Instead, very low frequencies were preferable probably because of lesser fatigue of the type I oxidative muscle fibres, even in limited CHF patients.

The low frequency pattern of EMS was used by Banerjee et al. in previous studies [16,17]. Using this protocol in moderate CHF patients (NYHA II/III), our group, (2009) reported significant improvement in functional capacity assessed by peak VO2 (10%, $P<0.05$), 6 minute walk test (7.5%, $P<0.005$) and quadriceps muscle strength (25%, $P<0.005$) [8]. Analysis of questionnaires related to the experience of using the shorts suggested a good level of adherence with the EMS.

Systematic reviews [18,19] highlight the lack of methodological quality in previous EMS studies and the need for a larger clinical trial before EMS of any frequency can be introduced into healthcare protocols more widely. Most recently, Smart et al. [20] published a meta-analysis of 10 RCT's of EMS *vs.* conventional training or placebo control in heart failure patients (an aggregate of 300 subjects, mainly in NYHA Class II and III). They concluded that although inferior to conventional exercise training, EMS elicited larger benefits in peak VO2, 6-minute walk distance and quality of life than placebo. Furthermore, EMS, of various frequencies, appeared to be safe with no increase in adverse events.

Several small studies of EMS, with varying protocols, mainly in patients with mild to moderate heart failure have been reported in the last decade showing modest benefit in exercise capacity and quality of life. Although modest when compared to conventional exercise training, this benefit appears real and will be probably quite crucial in those patients that cannot undertake exercise training for orthopaedic or other reasons, and perhaps in the symptomatic patients in NYHA Class III and IV as they often find physical exercise extremely difficult to undertake. We are launching a new EMS study on those with severe heart failure with great anticipation. The time for EMS training to be included in routine clinical prescription in heart failure is fast approaching but a large clinical trial of EMS for all comers with chronic heart failure is needed to seal the issues of the exact indications, protocol selection and the how much benefit to expect.

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Received January 13, 2013; **Accepted** January 15, 2013; **Published** January 16, 2013

Citation: Banerjee P, Ennis S (2013) Electrical Muscle Stimulation for Heart Failure: where do we Stand? J Clin Exp Cardiolog 4: e120. doi:10.4172/2155-9880.1000e120

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