MUSCLE FATIGUE, CARDIOVASCULAR AND HEMODYNAMIC RESPONSES INDUCED BY CLUSTER RESISTANCE TRAINING CONFIGURATION

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INTRODUCTION

The hemodynamic response alongside the resistance exercise (RE) set reflects the exercise pressor response. The loss of force along the RE (i.e. muscular fatigue) is compensated with an increment of the corollary discharge (i.e. central command) that activates motor and cardiovascular centres (Williamson, Fadel, & Mitchell, 2006; Williamson, 2010). Both central and peripheral mechanisms are responsible for the BP raises (Mitchell, 2013).

Traditional resistance training (TT) is the most widely studied way of RE and consists in perform every repetition of the set without rest until failure (Ahtiainen, Pakarinen, Alen, Kraemer, & Häkkinen, 2005; Izquierdo et al., 2006). Thus, large amounts of fatigue and discomfort (Hardee et al., 2012) are achieved. A novel approach in the management of the set configuration is the cluster configuration (CT) which consists in introduce pauses between single or small groups of repetitions (i.e intra-set rest training) maintaining the performance with a reduced perceived effort (Hardee et al., 2012). This type of intermittent RE has been showed to blunt the BP response during dynamic (Baum, Rüther, & Essfeld, 2003) and isometric exercise (Heffernan, Sosnoff, Jae, Gates, & Fernhall, 2008). However, the cardiovascular, hemodynamic and muscle fatigue in response to a CT configuration has not been yet explored.

Therefore, the goal of this study is to explore the muscle fatigue, cardiovascular and hemodynamic responses induce by CT in comparison with a TT resistance exercise protocols.

We hypothesized that central fatigue could be associated with a higher hemodynamic response.

METHOD

Eleven healthy sport science students participated in a total of 8 sessions, 5 of familiarization and 3 experimental sessions. Their mean age mean age (±SD), height, and body mass were 21.0 ±2 yr, 177.2 ± 0.08 cm and 72.4 ±6.6 kg, respectively. The first experimental session was conducted in order to calculate the time to failure during an isometric knee extensor exercise. This time was used to establish the individual work-pause for the second and third session in the isometric knee exercise.

The experimental protocol comprised a first session to test the time to failure (TTF) at a 50% of MVC to establish the load of the each set of the CT (20%TTF) and TT (80%TTF) sessions. The load for each session was completely equated in total time under tension, total rest and intensity but with different set configuration. Traditional set configuration session consisted in 4 sets of 50%MVC isometric at the 80% of the TTF of the test session with 180 seconds of rest between sets. Cluster configuration had 16 sets with the same intensity at 20%TTF with 33,75 seconds of rest. These training sessions were conducted in counterbalance order and one week apart. Neurophysiological and dynamic parameters were recorded before and after training sessions. Motor evoked potential (MEP), Short intracortical inhibition (SICI) and Intracortical facilitation (ICF) were measured using transcranial magnetic stimulation device; voluntary activation (VA), twitch force (TF), maximal M wave (Mmax) and low frequency fatigue (LFF) were calculated by electrical nerve stimulation. Maximal voluntary contraction (MVC) were recorded with a load cell. Hemodynamic parameters Heart Rate (HR), mean blood pressure (MBP), Rate Pressure product (RPP), Heart Rate Variability in frequency domain (total Power, low and high frequency; TP, LF, HF, respectively) were assessed also during the session. In addition, subjective perception of effort was also measured. Pearson and Spearman correlation test were used to test possible relationships between variables when normality were assumed or violated respectively.

RESULTS

ANOVAs showed a significant session*time interactions ($p<0.05$) over the following variables: MEP, SICI, VA, TF, LFF, HR, MBP, RPP, PSD, LF and HF, MVC. Post-Hoc analysis showed significant differences and after each session. There were significant differences between cluster and traditional training at the end of the sessions, indicating a higher change of these variables for the traditional session in comparison with the cluster session. We perform a correlation study between variables finding that the fatigue provoked by CT was not enough to find correlations whereas traditional set configuration have large correlations in the following variables: VA-RPP (r= -0,85) , VA-MAP (r= -0,65), VA-LF (r=0,69), LF-BRSup (r=0,68), SICI-BRSDown (r= -0,71), RPE-LFF (r= -0,75).

Discussion

Our findings shows that a cluster set configuration implicates lower central and peripheral fatigue with subsequent lower reductions in maximal force values as well as lower hemodynamic and neurocardiac stress than a traditional set configuration, even when both training sessions were equated for the work-pause rate.

This differences could be explained for the shorter time under tension in the sets of CT. Shorter times under tension implicates shorter periods of restricted blood flow in the exercising muscle and limiting the discharge of III and IV afferents that send signals to the cardiovascular control centre adjusting the hemodynamic response.

The greater hemodynamic response in TT configuration seems to be related with the magnitude of the exercise pressor reflex response and the central command. This, provoked a higher corollary discharge due to greater voluntary drive sent to musculature and greater hemodynamic response. Our findings support this idea with a consistent correlation between the central fatigue and cardiac stress. The greater central fatigue, the larger the hemodynamic response.

Therefore, the current data document the effect of set configuration as a main factor that had to be taken into account in order to control the fatigue responses.

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