THE PRE-EXHAUSTION METHOD SEEMS INEFFECTIVE TO INCREASE ELECTROMYOGRAPHIC ACTIVITY

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The purpose of this study was to investigate the effects of the pre-exhaustion method on the electromyographic activity (temporal and spectral domain) at different intervals of a set of resistance training. Twenty adults with little or no experience in strength training performed two sets of the seated row exercise at 70%1RM until muscular failure, in a randomized order. Surface electrodes were placed over the latissimus dorsi, teres major, biceps brachii, and posterior deltoid muscles of the dominant side. Results showed that the pre-exhaustion did not increase EMG activity of all muscle analyzed at any intervals of a set. Furthermore, the EMG median frequency decreased in teres major and posterior deltoid muscles during initial and intermediate repetitions. Results suggest that the pre-exhaustion induces more fatigue when compared to traditional training.

KEYWORDS: myoelectric, muscle activation, exercise order, pre-activation.

INTRODUCTION: Strength training is practiced through several exercises (single and multi-joint), and the exercise order influences the magnitude of electromyographic activity (Gentil, Oliveira, de Araújo Rocha Júnior, do Carmo, & Bottaro, 2007). Generally, training begins with multiarticular exercises in order to enhance the effects of strength training (Fleck & Kraemer, 2014). Differently, muscle pre-exhaustion (PRE), involves exercising the same muscle group to the point of concentric muscle failure using single-joint exercise immediately before multiarticular exercise (Brennecke et al., 2009). Both exercises (single and multi-joint) need to be realized until the point of total failure with approximately ten repetitions in each of them (Jones, 1970). The literature has shown that the influence of PRE on EMG activity of a specific target muscle, are divergent. Some studies have found that PRE increased the EMG on target muscle (Rocha Júnior et al., 2010), while others pointed a decrease in this activity (Augustsson et al., 2003). Still, other studies also have shown an increased EMG activity in accessory muscles without alteration of agonist's muscles (Brennecke et al., 2009; Gentil et al., 2007). Even with substantial wealth in the literature about PRE, the effect of PRE on the EMG activity of a specific muscle has not been fully elucidated. The lack of consensus in the literature shows the need to clarify whether this method increases muscle EMG activity on specific muscle grouping. Also, previous studies only analyzed the temporal domain of the EMG signal during PRE sets. Thus, verifying the spectral domain could reveal the behavior of fatigue during the exercises performed on this training method (Contessa, De Luca, & Kline, 2016). Furthermore, the previous studies did not analyze the EMG activity at different intervals thought the sets. Therefore, this study aimed to verify the effects of the PRE method on the electromyographic activity (temporal and spectral domain) among different intervals during sets at the seated row exercise, a commonly multiarticular exercise used by performers seeking to train the back, shoulders and elbow flexors muscles.

METHODS: We analyzed the EMG activity of latissimus dorsi (LD), teres major (TM), biceps brachii (BB), and posterior deltoid (PD) muscles of the dominant side. The sample size was composed of 20 adults (19.80±1.54 years; 71.92±9.39 kg; 177.28±7.07 cm) with little (maximum six months) or no experience in strength training. None of the participants were practicing strength training in the last 12 months. The participants declared no recent history of upper limb musculoskeletal injuries. The participants signed an informed consent form before performing data collection procedures, which is following the Helsinki Declaration (1983). Following, the 1RM test was performed using the Brzycki (1993) equation. The participants performed two sets of 12 submaximal repetitions as a warm-up, with 90-seconds intervals between sets. In sequence, there was five minutes interval, and then the load quantification test was performed. The cadence of exercises was two seconds for the concentric phase and two seconds for the eccentric phase (Gentil et al., 2007) controlled by a metronome app (Pro metronome - EUMLab - Xanin Technology, Hangzhou, China). After an interval of 4.55 ± 2.52 days, the EMG data were collected at the sampling frequency of 2000Hz using wireless electrodes (Trigno Wireless, Delsys, Boston, USA). The electrodes were placed over LD, TM, BB, and PD, following previous studies (Fujita, Marchi, Silva, & Gomes, 2019). After sensor placement, the participants performed a warm-up (2 sets of 12 repetitions) with 40%1RM on seated row and pullover exercises following the same cadence of load quantification tests. After the warm-up, the participants performed maximum isometric voluntary contractions (MVIC). For each muscle, the volunteers performed three trials of five seconds MVIC, with 90-seconds rest between then. Following, a five minutes rest was given to the participants. Then, they performed two sets of the seated row exercise at 70%1RM until muscular failure, in a randomized order (one with another without pre-exhaustion with pullover exercise) (Figure 1). Between each set of the seated row, there was a 20 minutes rest period, to avoid muscular fatigue (Augustsson et al., 2003). Volunteers were instructed to always seek for concentric muscle failure. The root mean square (RMS) value of each interval (two initial repetitions, two intermediate repetitions, and two final repetitions) was normalized by the MVIC of each muscle. For statistical analysis, six Multivariate Analysis of Variance (MANOVA) with 1 factor (pre-exhaustion) and two dependent variables (RMS and median frequency) were used with a significance level of 0.05. Three MANOVA represented the RMS in initial, intermediate, and final repetitions. The other three MANOVA represented the median frequency at the same intervals.

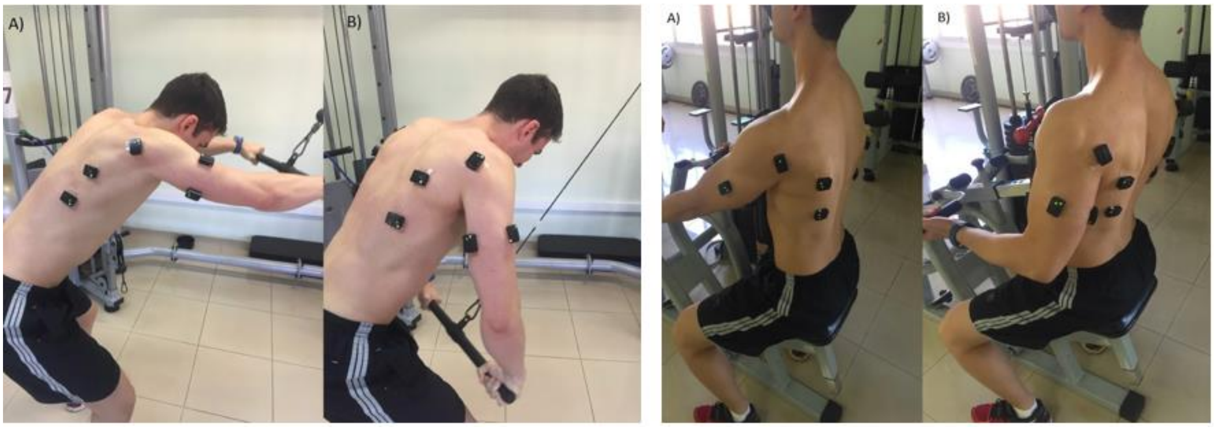

Figure 1: Volunteer positioning at the beginning of the concentric phase (A) and in the eccentric phase (B) at pullover (left) and seated row exercise (right).

RESULTS: MANOVA indicated no difference in EMG activity for the initial repetitions (p=0.140), intermediate repetitions (p=0.243), and final repetitions (p=0.359) (Figure 2).

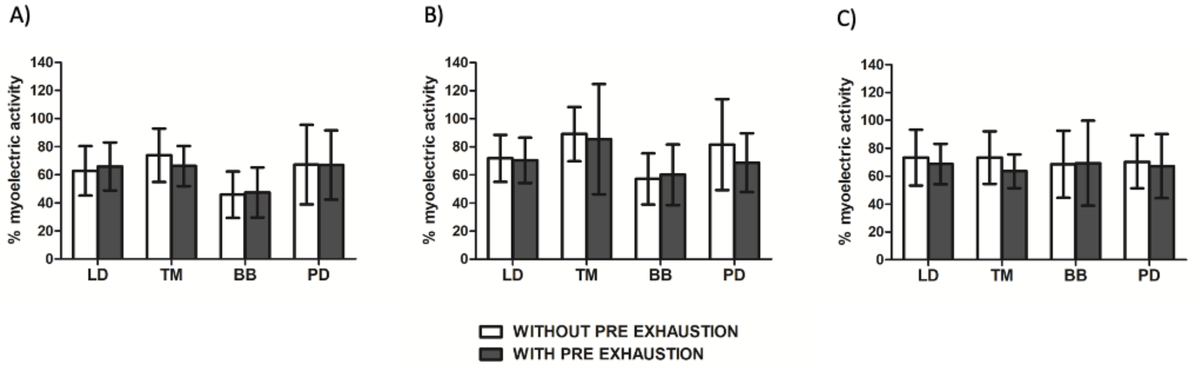

Figure 2: Means and standard deviations of the normalized root mean square (RMS) of electromyographic activity during two initial repetitions (A) two intermediate repetitions (B) and two final repetitions (C) in the different conditions of performing the seated row exercise. Note: latissimus dorsi (LD) teres major (TM) biceps brachii (BB) posterior deltoid (PD).

Regarding the spectral domain (Figure 3), MANOVA showed a difference in the median frequency for initial repetitions (p=0.009), intermediate repetitions (p=0.008), but no difference was found for final repetitions (p=0.222). In the PRE condition, the univariate analysis showed that median frequency in the TM (p=0.011) and PD (p=0.008) was smaller in initial repetitions. For intermediate repetitions this also occurred for TM (p=0.007) and PD (p=0.002). Only for BB in intermediate repetitions, the median frequency was high in the PRE condition in comparison to without PRE (p=0.032).

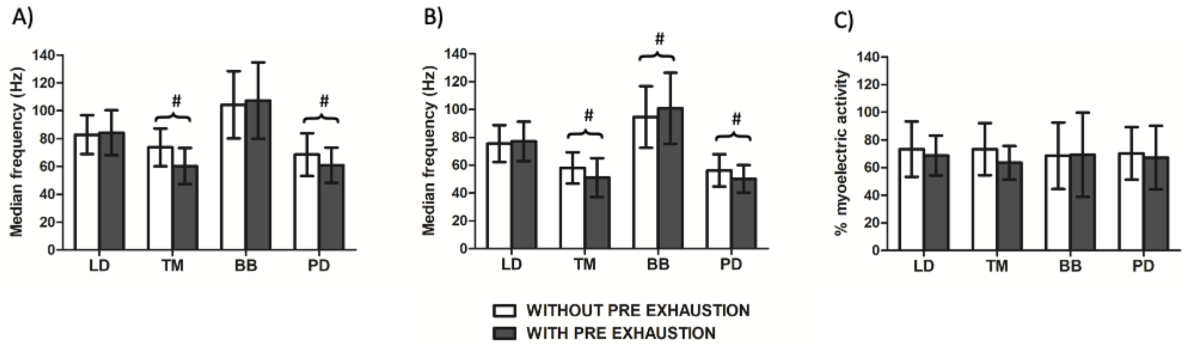

Figure 3: Means and standard deviations of the median frequency (F50) of electromyographic activity during two initial repetitions (A) two intermediate repetitions (B) two final repetitions (C) in the different conditions of performing the seated row exercise. Note: latissimus dorsi (LD) teres major (TM) biceps brachii (BB) posterior deltoid (PD). #denotes difference between conditions p<0.05.

DISCUSSION: The present study analyzed the effect of the PRE on the temporal and spectral domain of electromyographic activity at different intervals over a series of multiple repetitions. The main result revealed that PRE reduced the firing rates (median frequency) of motor units in the initial and intermediate repetitions. In the initial repetitions, the median frequency reduced 18.10% for TM, and 11.10% for PD in the PRE condition. Furthermore, at intermediate repetitions, these reductions also occurred: 11.80% for TM; 10.90% for PD. Our main results support the premise that muscle fatigue induces a reduction in firing rate (Contessa et al., 2016). However, in the final repetitions, there was no reduction in median frequency. Probably it happened because the participants realized maximum effort in both conditions (with and without PRE), reaching the same level of fatigue in the last repetitions. Moreover, the results of the current study disagree with the hypothesis of the pre-exhaustion method, which believes that using uniarticular exercise before a multi-joint exercise could fatigue and promote higher recruitment of the agonist muscle during subsequent multiarticular exercise (Jones, 1970). The results reveal that the EMG activity of the main agonist muscle (LD) did not increase in any of the three intervals analyzed with PRE condition. Previous studies have shown that PRE could increase EMG amplitude in target muscles (Barros Beltrão & Torres Pirauá, 2017; Rocha Júnior et al., 2010). However, the fact that Rocha Junior et al. (2010) used low intensities (30 and 60% 1RM) during monoarticular exercises, and multiarticular tasks (60% 1RM) could explain these positive effects. Furthermore, both exercises were not realized until concentric failure as suggested by Jones (1970). In the present study, the participants realized both exercises until concentric failure using the intensity of 70% 1RM. This different approach could explain the difference between our results with previous studies. Finally, our results showed that the number of repetitions realized in the seated row exercise with PRE was lower (8.75 ± 2.02) than without PRE (11.70 ± 2.43), corroborating the literature (Augustsson et al., 2003; Gentil et al., 2007). For a practical application, if the main exercise of a set is the multi-joint exercise, it should be done first to allow more repetitions, leading to a greater load (Gentil et al., 2007).

CONCLUSION: Accordingly to our results, we conclude that besides the PRE method seems to generate more fatigue in some muscles compared to conventional sets, it is ineffective to increase the EMG activity of the desired muscles.

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