ELECTROMYOGRAPHIC COMPARISON OF THE UPPER AND LOWER RECTUS ABDOMINIS DURING ABDOMINAL EXERCISES

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The purpose of this study was a comparative EMG analysis of three abdominal exercises in the activation of superior and inferior portions of rectus abdominis muscle. Young healthy adults (n=20) were analysed during the exercises by electromyography. All exercises were performed in a surface with 15^0 inclination. Two-Way Repeated Measures ANOVA was used to compare exercise and phase (conc. X exc.). Results shown that each portion was more active in inverse exercise with pelvic tilt, probably because it's higher intensity. Intensity of exercise seems to be more important than variation in activate abdominal muscle.

KEY WORDS: Electromyography, abdominal exercise, rectus abdominis.

INTRODUCTION:

Abdominal exercises (AE) are one of the most popular exercises used in fitness and training programs. The main goal of AE is to strengths the toraco-lumbar flexor muscles. There are a great number of variations described in specific and not specific literature.

Different patterns of AE were used to promote a complete stimulation of the abdominal musculature, however, this practice remains without a solid scientific base (Konrad *et al*., 2001; Sands and McNeal, 2002). Two principal techniques could be pointed out: curl exercise, where the superior body portion moves toward the inferior portion; and reverse exercise, with the inferior portion moving towards the superior portion.

The use of curl and reverse variations increased after Walters and Partridge (1957) and Partridge and Walters (1959) studies. Those researchers shown an increased electromyographic (EMG) activity at the inferior portion of rectus abdominis during the reverse abdominal exercise and superior portion predominance during the curl exercise.

Despite some methodological errors found on these studies (small samples, no statistical treatment or quantitative EMG analysis, and others), for decades this was the dominant dogma in the prescription of those exercises.

Recent findings are not in accordance with those preview studies. Escamilla *et al*. (2006), i.e., always found the EMG activity significantly higher at superior portion of rectus abdominis comparing curl and reverse exercises. In other way, Sarti *et al*. (1996) described that individuals with good technique were able to demonstrate higher activity at inferior portion during reverse exercise, despite this pattern were not observed in those without good technique.

The purpose of this study was to perform a comparative EMG analysis of three abdominal exercises based on the activation of superior and inferior portions of rectus abdominis muscle.

METHOD:

Sample: Twenty health young adults (25.7±3.6 years) without recent history of prolonged pain or injury in hips or spine were volunteered to the study. All individuals signed an informed consent before participation in the study.

Exercises: The EMG responses were analysed during the performance of three abdominal exercises. All exercises were performed in an 15^o-inclined surface. The exercises are illustrated in Figure 1.

Figure 1: Initial (upper) and final (lower) positions of analyzed exercises. From left to right: curl up (C), reverse (R), reverse with pelvic tilt (P).

Electromyography: Disposable surface electrodes were placed over both portions of rectus abdominis muscle, three centimetres superior and inferior em relation to umbilical scar, and three centimetres to the right side. Before the electrode placement, skin was shaved and cleaned with alcohol. These procedures followed the recommendations of Cram and Kasman (1998). The EMG signal was collected with ME3000 electromyograph (Mega Electronics Ltd), sampled at 1000Hz and filtered with pass-band of 10-500Hz.

Data Collection: Data were collected in one single session. After the anthropometric data, skin was prepared and the electrodes fixed. Each individual performed five consecutive repetitions in each exercise with a frequency of one repetition each three seconds. Between exercises was observed a ten-minute rest interval. Exercises were executed in a random order.

Data Analysis: The EMG signal from the first and last repetition of each exercise were excluded and the mean RMS (100 samples) signal from the other three repetitions was used as an indicative of EMG response to that exercise and individual. The signal was normalised to each muscle from the exercise with highest EMG intensity. To this exercise was attributed a value equal 1.0 and the other exercises were expressed as a percentage of that one.

Statistical Analysis: A *Two-Way Repeated Measures* ANOVA was used to each portion of the muscle with entries: phase (conc. X ecc.) and exercise. The Tukey-Kramer *post-hoc* was used when necessary.

RESULTS:

Figure 2 presents the EMG response related to the order in which exercise was performed. There were no significant differences in this arrangement, meaning that the rest intervals were sufficient.

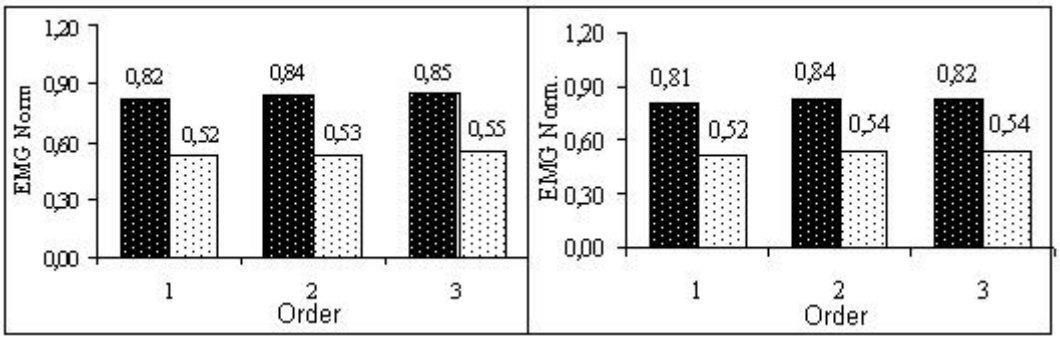

Figure 2: Normalized EMG activity of superior (left) and inferior (right) portions of rectus abdominis muscle related to the execution order. Concentric (dark) and eccentric (light) phases.

The normalised EMG responses for each portion at each exercise are presented in Figure 3. Statistical analysis indicated both phase (P<0,0001) and exercise (P<0,0001) as significant to both portions of rectus abdominis, with interactions (P<0,0001) between factors only to inferior portion.

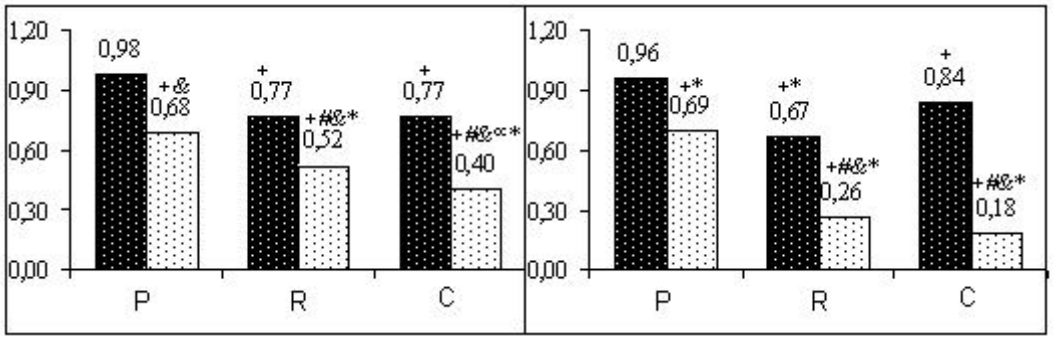

Figure 3: Normalized EMG activity of superior (left) and inferior (right) portions of rectus abdominis muscle related to the execution order. Concentric (dark) and eccentric (light) phases. + less than P conc.; # less than P ecc.; & less than R conc.; ∝ less than R ecc.; * less than C conc.

DISCUSSION:

Different ways to perform an exercise should change the pattern of activation of the specific musculature evolved. However, it is important to highlight that in the event of a single muscle it is impossible to contract one portion of rectus abdominis without to contract the other one – based on the "all or nothing" principle (Basmajian, 1957). With this in mind, this work is about to determine which exercise proportionate higher EMG activity at each portion.

Our results demonstrated that reverse exercise with pelvic tilt elicited greater activity from both portions, when compared to the other AE. We believe this is related with greater intensity from this exercise, which could be associated with two factors: worst lever arm and the pelvic tilt itself.

Comparing reverse and curl exercises, there were no differences between exercises at concentric phase in the superior portion of abdominal musculature. Our findings pointed out differences only at the eccentric phase, being higher at inferior portion of abdominal muscles. Considering the inferior portion of the abdominal musculature, it was most activated when performing concentric phase of the curl exercise, showing no differences on the eccentric phase.

Our results disagree from the popular concept that performing reverse abdominal the activation of the inferior portion of abdominal musculature will be increased and by doing curl exercise the activation of the superior portion will be greater. This idea is widely diffused in the gyms centres and other fitness environment. Our findings also disagree from Walters and Partridge (1957), Partridge and Walters (1959) and Willett *et al*. (2001). Sarti *et al*. (1996). They stated that individuals with good technique could elicit more activity from inferior portion performing reverse exercise, even though this pattern were not observed in those without good technique. The participants of the present study were highly trained, which is required to perform the reverse exercise with pelvic tilt, and they all have good technique in this specific skill, and that results were not observed.

Escamilla *et al*. (2006) found higher activity at superior portion of the abdominal musculature during curl exercises, compared to reverse exercises, without any detectable differences in the inferior portion. In spite of both movements were carried out in horizontal plane. The reverse exercise performed in an inclined surface demonstrated a higher activation in the superior portion than others did, and reverse exercise evidenced a greater activation of the inferior musculature portion.

Despite the partially different results, the study of Escamilla *et al.* (2006) reinforce the statement, also presented here, that exercise intensity is more important than the type of abdominal exercise performed.

CONCLUSION:

Our findings suggest that little difference be detected in the EMG activity of different rectus abdominis portions. However, our results illustrate the unconformity between the usual practice and scientific based observations and highlight the greater importance of exercise intensity to activate both muscle portions.

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