Efficacy of three abdominal exercises in order to test local muscle endurance

Original Article

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ABSTRACT: The study concerns the need of searching new models of abdominal tests, so that they can be updated and related to the motor gestures of abdominal exercises taught at the gyms in Rio de Janeiro. Therefore, the purpose is to evaluate the efficacy of trunk partial flexion, inverse flexion and complete flexion to test local muscular endurance by measuring the intensity of electromyographic signal of rectus abdominis muscle – superior, inferior and external oblique – and rectus femoris. The present study is a laboratorial model, a kind of descriptive research, and it was developed as a survey, according to THOMAS & NELSON (1990). The experiment was held at the Air Force Biomechanics Laboratory, using a surface electromyography device, with a sample of 14 male individuals, age 19 ±1.14 (years); weight 67.09 ± 6.14 (kg); height 177 ± 6.26 (cm) and body fat percentage 9.12 ± 2.88 (%). Variance Analyses was the statistic method used with Turkey’s post hoc and regression line coeffcient, statistical significance =0.05. The studied exercises were evaluated according to time parameters, checking the electromyographic signal intensity, as well as time and frequency parameters, analyzing the muscular fatigue during the exercises. Based on area and average parameters related to rectus abdominis muscle (superior, inferior and external oblique), there was not statistic difference between the tests. Therefore, none of the exercises required the use of those muscles any more than others. The rectus femoris muscle presented significant activity in complete flexion, in which there was the greatest intensity of the electromyographic signal. Therefore, that is the least indicated exercise to be used as test for abdominal endurance. If we consider fatigue, in the trunk partial flexion, the superior rectus abdominis muscle tends to reach fatigue faster than in the other exercises. In the trunk complete flexion, the external abdominal oblique reaches fatigue faster than in other exercises. The inferior rectus abdominis has not presented any tendency. We suggest that the best exercise to evaluate local muscular endurance of abdominal muscles, by the criteria fatigue, biomechanics and safety, is trunk partial flexion.

Keywords: abdominal exercises, electromyography, abdominal muscles, fatigue

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Submitted: November / 2001 Accepted: December / 2001

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INTRODUCTION

The practice of abdominal exercises has increased during the last decades due to esthetical and health needs of the population. Such increase is due to the several problems caused by weak abdominal muscles (VAZ and cols., 1999). Nowadays, thousands of people are doing abdominal exercises on an inadequate way which may cause damages to the spine (BEIN and cols., 1997). It is difficult for the student to have the body awareness of isolating the abdominal muscles during the performance of this exercise. PAUL (1991) states that the exercises for the strengthening of the abdominal muscles have suffered, along the recent years, changes in the way they should be performed. However, there are few scientific works showing the problems with the performance of the abdominal gestures (MELLO, 1986; GUIMARÃES, 1991 and VAZ, 1991 apud VAZ and cols., 1999).

According to KENDALL and McCREARY (1987), there are few mistakes in the exercises for the back, while there are many in the appropriate abdominal exercises. RASCH (1991) points out that 80% of the world population suffer from back aches. probably on the lumbar region. A flaccidity on the abdominal muscles, increased by obesity, is one of the reasons for the increase in the number of people having problems of back aches, (KNOPLICH, 1980).

The literature has references that show that the area of Measurements and Evaluation in Physical Education did not have the same research development as that of Physiology of Exercise. RIZZO apud FERNANDES (1999) points out that the production in the area of Measurements and Evaluation did not have the same research development as that of Physiology of Exercise. RIZZO apud FERNANDES (1999) points out that the production in the area of Measurements and Evaluation did not have the same research development as that of Physiology of Exercise. RIZZO apud FERNANDES (1999) points out that the production in the area of Measurements and Evaluation did not have the same research development as that of Physiology of Exercise. RIZZO apud FERNANDES (1999) points out that the production in the area of Measurements and Evaluation did not have the same research development as that of Physiology of Exercise.
According to GILLEARD and BROWN (1994) there are few information in the literature about the hand methods of testing abdominal muscles using standardized criteria and objectives in its evaluation of the muscle function. During the last decades, the knowledge regarding the abdominal endurance tests have stopped. (RIBEIRO and FERNANDES, 2000).

ANDERSSON and THORTSTENSSON (1998) commented that there is lack of standardization on the nomenclature and on the performance of the abdominal tests. It can be notice that there is a need for detailed studies, seeking the validation of new tests, with the same specificity of the motor gesture of the abdominal exercise being presently taught at the academies.

When analyzing the aspect of the abdominal tests, GILLEARD and BROWN (1994) stated that the level of the activity of the abdominal muscles in relation to the grades of the muscle tests has never been quantified. Therefore, the objective of the present study is to evaluate the efficacy of the trunk’s partial flexion, inverse flexion and full flexion exercises for testing the located endurance, from the analysis of the EMG signal of the muscle upper, lower and external oblique rectus abdominus and rectus femoris muscles, on individuals from 18 to 22 years old.

MATERIALS AND METHODS

Subjects

The sample comprised 14 Air Force male soldiers in the City of Rio de Janeiro, age between 18 and 22 years old, body fat average percentage 9.12%, according to Pollock’s and Jackson’s protocol, who used to make regular physical exercises, three times a week, with a good ability in the performance of the abdominal exercises and with no symptoms of abdominal pains or surgeries.

Instrumentation

The following instruments were used; to obtain the EMG signals, a four-channel ME3000P electromyraph (Mega Electronics, Finland). For the transmission of the signals to the computer and their analysis, a ME3000P software that comes with the electromyography device; a Pentium 300 computer. “Red Dot” 2231 electrodes (3M Brasil); a Lange compass with cutaneous folds; a Sanny metal metric tape; a small mattress; a Filizolla scale.

Experimental procedure

The studied abdominal exercises were: 1) partial trunk flexion, bending the spine; knees flexioned with the feet on the floor; 2) full trunk flexion, knees flexioned; feet held by the evaluator; and 3) inverse flexion, knees flexioned. The sequence of the movements was an alternation of each exercise among the evaluated individuals, i.e., the first evaluated person was doing a partial trunk flexion, the second one a full trunk flexion, the third one the inverse flexion, the fourth the partial trunk flexion and so on. The performance of each exercise is described as follows:

Partial trunk flexion, feet on the floor

The knees are flexioned on a 90° angle, the evaluated individual on a dorsal decubitus; the volunteer raises his trunk up to the point where the scapula is raised from the mattress; the fingers rest crossed behind the ears and the elbows closed. This procedure was adopted by SARTI and cols. (1996);

Full trunk flexion, knees flexioned, feet held by the evaluator

The hands shall be crossed behind the neck; the responsible for the test shall hold the feet of the volunteer; the volunteers’ elbows shall touch the knees, at the maximum flexion position; return completely to the initial position, before next flexion.

Inverse flexion, knees flexioned

With the person being evaluated at dorsal decubitus, the thighs are kept immovable during the exercise. This exercise consists on the raising of the hips, and the contraction of the abdominal muscles, to fold the pelvis backwards while pulling the sinfis pubiana up, into the direction of the chest. The lumbar region touches the mattress and the buttocks stay raised. This procedure was adopted by SARI and cols. (1996) and the hand of the evaluated individuals (at dorsal decubitus) shall lay on the ankles of the evaluator, so as the elbows of the evaluated person form a 90° angle with his trunk. The heels of the evaluated persons shall rest against on his gluteal region. The evaluated persons shall rest against the knees on the elbows in order a complete repetition is accomplished.

After each evaluated individual has completed an abdominal exercise, the EMG signal was visually inspected to see if there has not been any failure during the collection. If everything is correct, another participant was evaluated. It was necessary that an evaluator from the research team performed the counting of

Table 1 - Regression analysis - % of individuals with significant rate

<table>
<thead>
<tr>
<th>Muscles</th>
<th>Partial</th>
<th>Full</th>
<th>Inverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper rectus abdominus</td>
<td>71% (80%)</td>
<td>64% (100%)</td>
<td>50% (100%)</td>
</tr>
<tr>
<td>Lower Rectus abdominus</td>
<td>57% (63%)</td>
<td>57% (100%)</td>
<td>36% (60%)</td>
</tr>
<tr>
<td>External oblique</td>
<td>43% (67%)</td>
<td>57% (100%)</td>
<td>43% (100%)</td>
</tr>
</tbody>
</table>

Table 2 - EMG signal intensity

<table>
<thead>
<tr>
<th>Muscles</th>
<th>Significant difference between tests</th>
<th>Partial</th>
<th>Total medians</th>
<th>Inverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Rectus abdominus</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>lower Rectus abdominus</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>External oblique</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>Yes</td>
<td>7.79</td>
<td>78.17</td>
<td>22.39</td>
</tr>
</tbody>
</table>
the number of repetitions while the other was responsible to check the correct technique of the exercise of each evaluated individual. During the proposed exercises, the maximum number of repetitions in 1 minute, was carried out using the correct technique. If at any time the performance should not be correct, the exercise would be interrupted.

The criteria for the interruption of the partial trunk flexion were: could not raise the scapula from the floor; open the elbows that shall remain closed during the performance; to take impulse to accomplish the trunk flexion; to move the ankle (ex: raising) to make the exercise easier. The rectus inclination of approximately 30 degrees, according to the procedure adopted by GILLEARD and BROWN (1994). The rectus abdominus muscle, on its two portions, has been monitored at an average distance of 5cm above the umbilical scar or at the end of the concentric stage of the movement; to take an impulse in order to accomplish the trunk flexion and move the hips (ex.: raising), to make the exercise easier.

The criteria for the interruption of the full trunk flexion: not being able to rest the elbow against the knees; to pull too much apart the elbows; to apply, in a visible way, strength on the gluteal region; do not bend the spine, during the movement made with the spine straight; to raise the feet from the floor; not being able to make the exercise on a oriented way, mainly the concentric stage, supporting the descent; to stop for some seconds to rest.

The criteria for the interruption of the inverse flexion were: to move the legs during the performance; to remove the heels from the floor, during the movement; to take an impulse with the body in order to reach the concentric stage; to not bend the spine, making the motion with the spine straight; do not fully return the head and the spine, in relation to the floor, during the movement; to take an impulse in order to accomplish the trunk flexion and move the hips (ex.: raising), to make the exercise easier.

The criteria for the interruption of the partial trunk flexion were: not being able to rest the elbow against the knees; to pull too much apart the elbows; to apply, in a visible way, strength on the gluteal region; do not bend the spine, during the movement made with the spine straight; to raise the feet from the floor; not being able to make the exercise on a oriented way, mainly the concentric stage, supporting the descent; to stop for some seconds to rest.

All electrodes have been placed on the right side of the body to monitor the upper and lower, external oblique rectus abdominus and rectus femoris muscles. The rectus abdominus muscle, on its two portions, has been monitored according to the procedure adopted by VAZ and cols, (1999). The upper portion has been monitored at an average distance of 5cm above the umbilical scar and the lower portion at 6cm below the same point. Both pairs of electrodes positioned on this muscle were 3cm to the right of the average line of the individual. The external oblique muscle has been monitored 5 cm above the anteroupper iliac spine, with an inclination of approximately 30 degrees, according to the procedure adopted by GILLEARD and BROWN (1994). The rectus femoris muscle was monitored at 1/3 distant from the line between the anteroupper iliac spine and the upper edge of the patella.

**Method for the data analysis**

For the understanding of the study, it is necessary to describe the variables most used for the analysis of the EMG signal. The analysis methods, detailed below, may be developed either at the control of time or frequency.

**Analysis of time domain**

Initially the Average Rectified Value (ARV) was calculated for each muscle, during each test and for each individual. To calculate the ARV, the minimum points of each channel (muscles) were marked and at each interval, and at each test. The system itself makes the calculations of the values of averages, areas and peaks at these intervals.

The studied variables, from the computation of the ARV were: average (Me) – ARV signal average at a given interval; peak (Pi) - ARV maximum value at a given time; area (Ar) - is the product of intensity by the time at a given interval; normalized average (MeN) – is the value of the Me variable of each muscle, of each individual, divided by the maximum value of the Pi variable of the same muscle, of the same individual.

**Analysis of the frequency domain**

The ME3000P software allows the computation of variables associated to the signal power spectrum. In this case, the Fast Fourier Transform (FFTs) of the 1.024 points windows were computed with the objective of verifying the behavior of the EMG frequency spectrum along the test. This is done through the software’s “Fatigue Test”, to determine the fatigue level of each muscle during each exercise. The variables originated by this test were: median frequency variation rate (MF) – is the MF variation in time, expressed as Hz/min and the variation rate of the mean power frequency (MPF) – is the MFP variation in time expressed as Hz/min.

**Statistical handling**

To compare the intensity of the muscle activity between the three tests the Analysis of Variance (ANOVA) was used between the mean, area and normalized mean variables. If a statistically meaningful difference should be identified, the Tukey’s “post hoc” test was performed. To investigate the fatigue, through the temporal analysis, the linear regression coefficient was calculated. The objective of this analysis was to verify the trend of the muscle

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Significant rate</th>
<th>Partial (%)</th>
<th>Total medians (%)</th>
<th>Inverse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Rectus abdominus</td>
<td>Yes</td>
<td>22.8</td>
<td>21.5</td>
<td>27.8</td>
</tr>
<tr>
<td>Lower Rectus abdominus</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>External oblique</td>
<td>Yes</td>
<td>19.3</td>
<td>23.8</td>
<td>23.6</td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Significant rate</th>
<th>Partial (%)</th>
<th>Total medians (%)</th>
<th>Inverse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Rectus abdominus</td>
<td>Yes</td>
<td>-30.80</td>
<td>-.20.25</td>
<td>26.81</td>
</tr>
<tr>
<td>Lower Rectus abdominus</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>External oblique</td>
<td>Yes</td>
<td>-6.82</td>
<td>-10.34</td>
<td>-1.99</td>
</tr>
</tbody>
</table>
activity along the test, since the regression coefficient is a good
trend’s stimulator on temporal series (WILLIAM, 1986).

The verify the fatigue at the frequency domain the ANOVA was
used, sole factor comparing the MF and MPF variation rate of each
muscle group during each exercise. After identifying the difference
statistically meaningful, the Tukey’s “post hoc” was performed.
The significance rate adopted was = 0.05.

RESULT AND DISCUSSIONS

Several parameter were extracted form the EMG signals of the
studied muscles, from the 13 exercises and the 14 individuals.
Parameters at the time and frequency domain were analyzed and
the basic objectives were to identify the tests that produced more
muscular activity and that showed a faster fatigue.

1st Parameter – Average (Me)

Initially, the results of the regression analysis are shown and
subsequently the comparison between the intensity of the muscle
activity from the three tests.

a) Upper Rectus abdominus muscle: on the partial flexion,
71% of the sample (n =10) had a significant coefficient; 80% from
this group (n = 8) showed a trend to increase the activity
along the test.; 29% had no significant trend; on the full flexion,
64% (n = 9) had a significant coefficient, and all from this group
showed a trend to increase the activity along the test; 36% had
no significant trend; on the inverse flexion 50% (n = 7) had a
significant coefficient, and all from this group showed a trend to
increase the activity along the test; 50% had no significant trend.

b) Lower Rectus Abdominus Muscle: on the partial flexion,
57% of the sample (n =8) had a significant coefficient; 63% from
this group (n = 5) showed a trend to increase the activity
along the test.; 43% had no significant trend; on the full flexion,
75% (of sample (n = 8) had a significant coefficient, and all from
this group showed a trend to increase the activity along the test;
43% had no significant trend; on the inverse flexion 36% (n = 5)
had a significant coefficient, and 60% from this group (n = 3)
showed a trend to increase the activity along the test; 64% had
no significant trend.

c) External oblique muscle: on the partial flexion, 43% of
the sample (n = 6) had a significant coefficient; 67% from this
group (n = 4) showed a trend to increase the activity along the
test.; 57% had no significant trend; on the full flexion, 57% (n =
8) had a significant coefficient, and all from this group showed
a trend to increase the activity along the test; 43% had no signifi-
cant trend; on the inverse flexion 43% (n = 6) had a significant
coefficient, and all from this group showed a trend to increase
the activity along the test; 57% had no significant trend.

d) Rectus femoris muscle: as, generally speaking, this muscle
showed a very small activity, the fatigue evaluation lost its sense.

Therefore, the results for this muscle do not contain those related
to the trend analysis by regression coefficient.

a) Upper Rectus Abdominus, lower and external obli-
que muscle: from the point of view of EMG intensity signal
(partial, full, inverse) the three exercises on these muscles were
analyzed, through the mean parameter and the area parameter
averages from the analysis of variance (ANOVA) and then the
Tukey’s “post hoc” treatment was applied. It was not noticed a
statistical difference between the three exercises, showing that
the muscle activity does not depend on the exercise; then, none
of the exercises showed the need of demanding more from the
investigated muscle than from the others.

2nd parameter: Normalized Mean = MeN

a) Upper/external oblique Rectus abdominus muscle: these
muscles had significant coefficients during the three abdo-
menal exercises studied for the 14 individuals. Through the mean
values of each exercise there is an indication that the most intense
muscle activity, on the upper rectus abdominus muscle, was the
inverse flexion, followed by the partial flexion and, lastly, the
full flexion. On the external oblique muscle there in an indication
that the most intense muscle activity was the full flexion, followed by
the inverse flexion and, lastly, the partial flexion.

b) Lower Rectus Abdominal Muscle: it was noticed
any statistical difference between the three abdominal exercises
studies, indicating that the muscular activity does not depend on
the exercise. Therefore, there is no indication that an exercise is
better than the other, i.e., if its muscle activity is more intense.

c) Rectus femoris muscle: there was no difference between the
exercises. It is important to emphasize that the muscle activity of
this muscle is very small and therefore its results are not significant.

3rd Parameter – Frequency (Fr) represented by Median Frequency
(MF)

The objective of the analysis of the parameters at the Fr domain
is to watch the fatigue.

a) Upper Rectus abdominus Muscle: this muscle had on
the abdominal exercises studies, for the 14 individuals, significant
coefficients. Through mean values of each exercise, there is an
indication that the fall rate of Fr was greater on the partial flexion,
meaning that this exercise has a trend to reach the fatigue faster
than the others, followed by the inverse flexion and next by the
full flexion.

b) Lower Rectus Abdominal Muscle: this muscle did not
have on the three abdominal exercises studied, for the 14 indivi-
duals, a statistically significant difference. Therefore, there is no
indication that the exercise caused more fatigue than the other,
i.e., it cannot be affirmed that there is a trend for greater fatigue
on a specific exercise.

Table 5 - Median Power Frequency (MPF)

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Significant rate</th>
<th>Partial (%)</th>
<th>Total medians (%)</th>
<th>Inverse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Rectus abdominus</td>
<td>Yes</td>
<td>-32.71</td>
<td>-21.72</td>
<td>-27.35</td>
</tr>
<tr>
<td>Lower Rectus abdominus</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>External oblique</td>
<td>Yes</td>
<td>-6.82</td>
<td>-12.25</td>
<td>-3.50</td>
</tr>
</tbody>
</table>
c) External Oblique Muscle: the ANOVA revealed a significant difference among the exercises for this muscle. The “post hoc” showed that the fall rate of Fr was greater on the full flexion, meaning that this exercise has a trend to reach fatigue faster than the others, followed by the partial flexion and next by the inverse flexion.

4th Parameter – Frequency (Fr) represented by the Mean Power Frequency (MPF)

Upper Rectus Abdominus Muscle: for this muscle there is an indication that the fall rate of Fr was greater on the partial flexion, meaning that this exercise has a trend to reach fatigue faster than the others, followed by the inverse flexion and next by the full flexion.

b) Lower Rectus Abdominus Muscle: it was not found any significant difference between the three exercises. Therefore, there is no indication that the exercise caused more fatigue than the other, i.e., it cannot be affirmed that there is a trend for greater fatigue on a specific exercise.

c) External Oblique Muscle: the statistic tests revealed that the fall rate of Fr was greater on the full flexion, meaning that this exercise has a trend to reach fatigue faster than the others, followed by a partial flexion and next by an inverse flexion.

CONCLUSIONS AND RECOMMENDATIONS

It has been a problem to develop a test to evaluate the fitness for abdominal muscles, since there is no criteria for measuring (SPARLING, 1997). Up to the present, the activity of the abdominal muscles is being more studied than the abdominal tests complying with scientific authenticity criteria.

In relation to the intensity of the muscular activity, the normalized mean suggests a significant difference between the muscular activity for the exercises. The normalization of the EMG signal has been widely discussed in the literature. Its main objective is to reduce the variance among subjects. However, it has been proposed that some normalization methods may introduce trend errors, thus compromising the statistical tests reliability (OLIVEIRA and cols, 2001). Therefore, in spite of the great individuals differences inherent to the methods itself, statistics based on the non-normalized mean and area parameters give us more reliable results.

Based on these parameters, either on the area or on the mean, in relation to the upper, lower and external oblique rectus abdominus muscles, there has not been a statistical difference among the tests, thus none of these exercises revealed requiring more from the muscles investigated than from the others. In relation to the rectus femoris muscle, he showed a significant activity on the full flexion, where there has been a greater intensity of the EMG signal. These results suggest that the full flexion is the less indicated to serve as a RML test of the abdominal tests since it is the exercise that works more the rectus femoris in relation to its demand. This supports what has been suggested by SPARLING (1997), who affirmed that the full trunk flexion test, due to the accumulated evidence in relation to its safety and validity, is not the most selected one to evaluate the abdominal fitness. In addition, the motor gesture of this exercise differs from what is presently applied at the gyms, causing the evaluated person to have problems with its performance. BEIN and cols (1997) concluded that due to the concern about the safety of performing a full trunk flexion, the partial one is now being performed. According to HALPERN and BLECK (1979), the partial trunk flexion by raising it until the scapula is raised from the mattress (a procedure adopted during the exercise performed in our study) requires the minimum flexion of the lumbar spine. Therefore, this exercise is the most indicated since it does not cause any discomfort or pain.

In relation to the fatigue aspect, the upper rectus abdominus muscle showed a fall rate of Fr., with a trend to reach the fatigue faster that on the partial trunk flexion exercise. The lower rectus abdominus muscle did not show any trend and the external oblique muscle, on its turn, revealed a trend to reach fatigue faster on the full trunk flexion.

The trend of the group, of increasing or decreasing its muscular activity, may be determined by he regression equation. On the upper rectus abdominus muscles and lower, most of them showed a trend to increase the activity along the partial and full flexion tests. On the external oblique muscle, only on the full flexion there has been a trend to increase the activity during its performance.

A matter that deserves reflection in this study is about what is going to determine the efficacy of the abdominal exercise to serve as a located endurance muscle test: either if it is the exercise that reaches fatigue faster, although with a less muscle intensity, or if it is the exercise that reaches the fatigue slower, although with a greater muscle intensity; in other words, if it is the muscle intensity or the fatigue. Among the several definitions in the literature about the term muscle endurance, it is valid to quote that of BALADY and col. (2000) who mention the concept from the American Sports Medicine College: “…it is the ability of a muscle group to perform repetitive contractions for a period of time sufficient to cause muscle fatigue…”. Therefore, for the RML test, the most important is the degree of fatigue and not the degree of muscle intensity.

Finally, there is a strong suggestion that the best exercise to evaluate RML of the abdominal muscles, under the aspects of fatigue and safety, is the partial trunk flexion, considering as main muscles the rectus abdominis upper and lower.

On future studies, it is recommended to establish a protocol of cadence or the rhythm of performance of the abdominal exercise, seeking a good performance quality, on which the evaluated person performs, either the eccentric stage and the concentric one, on a slow and oriented way. SPARLING (1997) recommends the use of the cadence test rather than the speed test (Pollock’s Abdominal test) to evaluate the located muscular endurance (Ex.: 25 repetitions per minute), by selecting difficulty levels in accordance with the level of training of the evaluated person. It is also interesting to mention that the relationship of the EMG with the amplitude of the flexion trunk movement, to verify what occurs with the EMG signal when the hip flexors become more acting than the abdominal muscles; to increase the number of samples; and to research on the abdominal power test, since the power is a fundamental physical quality to the balance of the human body, either on the aspect of articulations or on the muscles, increasing the functional ability of the individual for the daily tasks.
REFERENCES


