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Effects of Massage Over the Psychophysiological Aspects of Acute Muscle Fatigue

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Abstract

Purpose: The aim of the study was to analyse the behaviour of the anterior deltoid muscle induced by an isometric contraction and its response to the therapeutic massage, using the surface Electromyography (EMG), Visual Analogic Scale (VAS) and Pain Pressure Threshold (PPT).

Methods: Twenty sedentary students, between 18 and 30 years old, were randomly selected, and equally divided in two groups: control (Rest) and trial (Massage). The EMG data gathering, VAS and PPT were made in the anterior deltoid muscle of the non-dominant upper limb from the subject, he was instructed that should maintain a resisted isometric contraction with 3 kilograms attached to its wrist in an anterior shoulder flexion in 90º for a maximum amount of time in four contractions to assure muscle fatigue induction.

Results: In comparative analysis of the rest group in relation to the massage group, referring to the contraction time, the fatigue perception and the pain threshold indicate that in one of these aspects the massage group overlap to the rest group. The intragroup electromyographic response for fatigue installation and muscle recovery presented values of $p<0.001$.

Conclusion: The therapeutic massage showed alterations in the muscle fatigue psychophysiological variables, however, compared to the trial group, it was confirmed by the EMG.

Keywords: Fatigue; Massage; Electromyography

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Introduction

Neuromuscular fatigue is defined when the muscle becomes incapable of generating muscle power or strength after exercise or long repetitive activities. As well as the inability to maintain optimum performance and generate maximum voluntary contractions during a physical exercise. The rupture of muscle fibers caused by the stress generated by exercise causes musculoskeletal pain associated with fatigue. The genesis and proportion of muscular fatigue depend on the type of exercise, the type of recruited muscular fibers and the physical preparation of the individual, which justifies the difficulty to study this matter [1-4].

Acute fatigue is defined as metabolic changes that contribute to decreased strength and altered excitation-contraction-relaxation capacity of the muscular nerve fiber, culminating in a decreased frequency of muscle activation. Based on this principle, muscular pain caused mainly by fatigue, cannot only negatively interfere with activities of daily living, but also with athlete's performances [3,5-8].

The neglected time necessary to restore substrates used during the effort before undergoing a new stimulus is an inadequate condition, since they prevent the organism from being in an optimal state to perform activities that induce fatigue, limiting the performance and increasing the risk of injury. To enhance recovery, it has been observed in clinical practice the use of methods such as rest and therapeutic massage [9,10].

The spectrum of muscle fatigue, despite its difficult etiology, can be measured by surface Electromyography (EMG), as well as its progression and modulation [11]. At the same time, methods such as Pain Pressure Threshold (PPT) and a visual analogue pain scale can complement the EMG data with a psychophysiological aspect [12]. Studies report that athletes and patients suffer the effects of muscle fatigue during exercises and physiotherapy sessions, a fact that can interfere in the performance of therapeutic activities; daily life and work [1,13]. However, there are few evidences on this subject, especially regarding the acute effects of physiotherapeutic resources on muscle fatigue [14].

In this context, the objective of this study was to demonstrate how massage could modulate the psychophysiological aspects of acute muscle fatigue.

Material and Methods

This was a cross-sectional, descriptive, analytical and experimental study with a quantitative approach, with the ethics committee approval from the State University of Paraíba over the number 44989015.1.0000.5187. The study consisted of a sample of 20 males aged between 18 and 30 years, healthy, not practicing physical activity and randomly selected. All subjects participated until the end of the study. These, were divided into two groups: control group (rest) and experimental group (massage). Men who were using dietary supplementation, hormone therapy, had lesions in the limb to be studied, or had metabolic problems were excluded from the study.

Due to its reduced size and volume, the individual's anterior deltoid muscle was chosen because its EMG frequency is easily detectable, since the area above it presents little impedance due to the smaller amount of adipose tissue to the muscular fibers, quality that is sought for EMG reading [15,16].

All subjects performed four resisted muscle contractions, with 3 kg up to their maximum contraction limit, in a shoulder anterior flexion movement up to 90º in relation to the ground. This protocol was performed so that there was a cumulative response of the physiological effects of acute muscle fatigue; your potentialization was sought from the repetitions of isometric contractions, as well as the application of the fatigue modulator for one minute between these contractions. According to Froyd, Millet and Noakes [10], the physiological recovery of neuromuscular fatigue begins immediately after cessation of exercise. From this moment, the intervention of only one minute for massage or rest is justified to verify the short-term effects of these resources.

To measure the time of massage, contraction and rest Vollo® chronometers were used to indicate how long the individual maintained the contractions and the time of the resource of exactly 1 minute.

The fatigue perception, according to Shahid et al., [17], was analyzed using a Visual Analogue Scale (VAS), with a field that characterized its quality with five descriptions (without, light, moderate, intense and maximum fatigue), and below a field which characterized the amount of fatigue reported by the subject, with a number from 0 to 10, without fatigue and with maximum fatigue, respectively. This VAS is similar to the one applied for the pain measure [18].

A variable (PF) was created to the VAS analysis, which consists in the difference between the perception of fatigue, collected before and after the muscular contractions, with which it was possible to analyze the perception of fatigue consequent to the application of massage or rest.

For the Pain Pressure Threshold (PPT), an algometer (FPK Algometer - Pain Test®, Greenwich, Connecticut, USA) was used, being applied to the anterior deltoid muscle in its midpoint through an access between the electrodes. This data and were always gathered by the same evaluator who instructed the volunteers to speak the word "pain" when the sensation of pressure began to become painful (threshold), ceasing the stimulus. These values were registered in kg/cm².

For the analysis of the PPT was performed using another variable (PPT), referring to the pressure threshold after each muscle contraction, which allowed the comparison of the effects of each resource (massage or rest).

In order to capture the EMG signal, the MIOTEC® Electromiograph Miotool was used with disposable Ag/AgCl surface electrodes arranged transversely to the muscle fibers of the anterior deltoid according to SENIAM standards. This capture was performed with Butterworth 4th order on-line filters with low-pass/high-pass of 10-500μv.

Corresponding to the initial 5 seconds of the contraction spectrum captured by EMG, the Initial Median Frequency (IMF) was delimited. For the Final Median Frequency (FMF), the 5 final seconds were selected. Another two variables were created to demonstrate the effects of the isometric contraction tests: The Fatigue Installation (FD) was given by the mean difference between IMF and FMF, while Recovery (REC) after the use of the resource (massage or rest) by the mean difference between FMF and IMF.

Statistical analysis

The data of the collected variables were analyzed with the software Statistical Package for Social Sciences (SPSS) in its version 23.0, where the data of the descriptive statistical analysis (mean and standard deviation) were obtained. The Kolmogorov-Smirnov test was used to verify the normality of the data, as well as Student's t-test for independent variables (intragroup analysis) and paired (intergroup) with a significance level of 95% (p<0,05).

Results

In comparative analysis of the Rest group in relation to the Massage group, referring to the contraction time (Table 1), the fatigue perception (Table 2) and the pain threshold (Table 3) indicate that in none of these aspects the Massage group overlap to the Rest group.

Noting that regardless of the chosen procedure, there is no interference in the duration of contractions, the perception of fatigue or the pain threshold between the groups (p<0.05).

Table 1: Muscle contraction time analysis between groups.

Contractions	Groups	Mean±STD	t Value	*p* (p<0,05).
T1	Res.	64,70±24,94	1,88	0,18
	Mass.	81,70±30,18		
T2	Res.	46,70±24,34	1,66	0,21
	Mass.	60,70±24,16		
T3	Res.	43,50±16,45	0,49	0,49
	Mass.	47,40±6,31		
T4	Res.	45,90±13,09	0,01	0,90
	Mass.	45,20±11,78		

Source: Research, 2019. T: Muscle contraction time; STD: Standard Deviation; Res: Rest; Mass: Massage

Table 2: Comparative analysis of muscle fatigue perception between groups.

FP	Groups	Mean±STD	t Value	*p* (p<0,05).
FP1	Res. Mass.	5,55±2,39	0,075	0,788
FP2	Res. Mass.	6,65±2,23	0,241	0,629
FP3	Res. Mass.	7,28±2,38	0,102	0,753
FP4	Res. Mass.	7,88±2,24	0,414	0,528

Source: Research, 2019. FP: Fatigue Perception (difference before and after contraction); STD: Standard Deviation; Res: Rest; Mass: Massage

Table 3: Comparative analysis of pain pressure threshold after muscle contraction between groups.

Tests	Groups	Mean±STD	t-Value	*p* (p<0,05).
Baseline	Res. Mass.	2,75±0,88	0,39	0,84
PPT1	Res. Mass.	2,81±0,99	1,83	0,19
PPT2	Res. Mass.	2,65±0,74	0,02	0,88
PPT3	Res. Mass.	2,69±0,90	0,96	0,33
PPT4	Res. Mass.	2,66±0,72	0,58	0,45

Source: Research, 2019. PPT: Pain Pressure Threshold; STD: Standard Deviation; Res: Rest; Mass: Massage

Table 4: Intragroup analysis between median frequencies of EMG for fatigue installation and muscle recovery.

Test	Groups	Mean±STD	t-Value	*p* (p<0,05).
FD1	Res.	17,83±9,93	5,67	<0,001
	Mass.	26,95±12,86	6,26	<0,001
FD2	Res.	18,48±7,19	8,11	<0,001
	Mass.	21,77±8,50	8,10	<0,001
FD3	Res.	21,70±10,39	6,60	<0,001
	Mass.	19,94±5,89	10,70	<0,001
REC1	Res.	18,41±6,70	8,68	<0,001
	Mass.	25,73±8,68	9,36	<0,001
REC2	Res.	19,89±5,90	10,65	<0,001
	Mass.	21,55±4,65	14,64	<0,001
REC3	Res.	19,36±8,46	7,22	<0,001
	Mass.	18,26±7,35	7,85	<0,001

Source: Research, 2019. FD: Fatigue installation; REC: Muscle recovery; STD: Standard Deviation; Res: Rest; Mass: Massage

The intragroup electromyographic response for fatigue installation (FD) and muscle recovery (REC) presented values of $p<0,01$ (Table 4).

However, intergroup analysis shows that only in the first recovery phase (difference between FMF and IMF between the first and second contractions) there was a significant difference ($p<0,05$) (Table 5).

Table 5: Intergroup analysis between median frequencies of EMG for fatigue installation and muscle recovery.

Test	Groups	Mean	t-Value	*p* (p<0,05).
FD1	Res.	17,83±9,93	3,14	0,93
	Mass.	26,95±12,86		
FD2	Res.	18,48±7,19	0,87	0,32
	Mass.	21,77±8,50		
FD3	Res.	21,70±10,39	0,21	0,64
	Mass.	19,94±5,89		
REC1	Res.	18,41±6,70	4,44	0,05
	Mass.	25,73±8,68		
REC2	Res.	19,89±5,90	0,48	0,50
	Mass.	21,55±4,65		
REC3	Res.	19,36±8,46	0,96	0,76
	Mass.	18,26±7,35		

Source: Research, 2019. FD: Fatigue installation; REC: Muscle recovery; STD: Standard Deviation; Res: Rest; Mass: Massage

Discussion

According to the physiological effects of the massage indicated by Mori et al., [19], the isolated groups of Massage and Rest indicate that both are effective for modulating fatigue, there is no indication that massage induces the individual to maintain isometric contractions for a greater amount of time. Andersen et al., [20] concluded that active warm-up and massage can reduce severe muscle soreness, but the effect may level off within an hour, and showed the positive effect of massage on soreness was still significant one hour after the cessation of treatment and with by significant increases in PPT.

Mori et al., [19] indicates that the massage applied to the region is more effective than rest in the fatigue perception, in the pain threshold and in the electromyographic response; similar to the findings of Froyd, Millet and Noakes [10] and Jay et al., [3], were the resource application was more than one minute, which differs from the perspective of this study: in which the resource was applied for exactly one minute between the series of contractions to evaluate the effect recovery between sets and its cumulative effects.

Jay et al., [3] showed with 22 untrained healthy men, the pain modulation with massage application for 10 minutes after exercise, found positive response from massage related to rest, where through the pressure pain threshold it was possible to state that massage is a better resource regarding pain modulation assessed by PPT. Thus, it is understood that the longer the time of application of the massage, the greater its effects.

Between massage and rest there is little significant change in the results obtained in EMG, although, corroborating with the study of Mori et al., [19] it may have been influence on the median frequency in the two situations independently. Our study shows that is possible to notice that the fatigue seems to increase in each test in the Fatigue group and decrease in the Recovery group, however, not enough to show significant difference between the two groups. We hypothesize that this behavior is justified by the time the resources were applied, given that other study showed satisfactory results in applying massage to recover muscle fatigue [3].

There have been changes in muscle performance due to massage therapy in comparison to rest, but only in a subjective nature, that is, at the sensorial level, which can be explained by the gate control theory (tactile stimuli are superimposed on the stimuli) that can modulate the local painful sensation [19].

Many sports medicine practitioners, based on observations and clinical practice, believe that massage may have beneficial effects in post-exercise recovery, such as the intervals between rounds of sports fighting [21]. With this, several studies show that the massage, although widely used, does not have its real potentialities defined [22-24]. This may be related to the variety of protocols used without standardization [9].

In view of the discussion presented, it is noted that there is a shortage of studies that evaluate the physiotherapeutic response in short-term exercises, as well as the use of other therapeutic modalities and protocols for the treatment of the immediate and cumulative effects of muscle fatigue.

Conclusion

We conclude that it is possible to note the presence of the psychophysiological response regarding the therapeutic massage in acute muscle fatigue, although, among the evaluation resources of its modulation used in this study there was no indication that this treatment method overlies the rest in the improvement of the acute fatigue induced by isometric contraction.

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