INTRODUCTION

The style of current life and the use of new technologies, which become the life and the work easier, have contributed to the sedentary behavior. A large number of hours working day have become the practice of some physical activity for the maintenance of the health very difficult. Compromising the quality of life and the health of the worker, the competitive modern world has become the life each day more stressful (CANETE, 1996).

The sum of all this stressful factors emotional and physical is considered as one of the probable causes of muscle pain and myofascial pain. The strain muscle, which produces pain in distinct places of the body, is characteristics of myofascial pain (AULECIEMS, 1995). Pain or discomfort muscle is characterized as being a primary pain that affect continuously the muscular demand (KNOPFICH, 1986). In any one of the cases, the muscle that presents more pain crises is the upper trapezius due to the fact of this region to be very susceptible to the strain and tensions.

As said by CANDOTTI & PRESSI (1999), it is commented in several studies that there is a common complaint about pain and discomfort in the upper trapezius region between the workers from different sectors. In this way, it seems that all the tension and concern are vented on this muscle, so that to cause pain and to compromise the quality of life. The evidence for this is that the incidence of pain on trapezius muscle is 84% bigger than another muscles of body, what represents a greater predominance of complain about pain myofascial (YUNUS et al., 1981).

Traditionally, the evaluation of muscular pain and myofascial pain is carried through subjective form what consider as just only the complaint of the individual. In this way, it is understood important to investigate lens form of evaluation of pain muscular.

According to CANDOTTI (1997) and MARTINEZ (1997) pain muscular, independent of body region, can be evaluated when the muscle in question is submitted to a monitored protocol of muscular fatigue located with surface electromyography (EMG).

A quantity of authors believes that individuals with pain muscular tend to present higher indices of fatigue and that these indices can be quantified with EMG (De LUCA, 1993). Thus, the aim of this study was to verify whether the use of the surface EMG in the frequency domain (MF) could identify subjects with and without pain in the upper trapezius.

MATERIAL AND METHODS

Subjects

This research was ex-post-facto type. The experimental group was comprised of subjects with pain (n=10) and subjects without pain (n=5). All the individuals of group with pain reported having at least one episode of muscle pain during the last month. Table I presents the average values of the age, corporal mass and stature of this individuals.

Table I The average values of the age, corporal mass and stature of the individuals.

<table>
<thead>
<tr>
<th></th>
<th>Age (Years)</th>
<th>Mass (Kg)</th>
<th>Stature (cm)</th>
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<tbody>
<tr>
<td>With pain (10)</td>
<td>28,8 ± 8,2</td>
<td>62,6 ± 9,8</td>
<td>168 ± 7,5</td>
</tr>
<tr>
<td>Without pain (n=5)</td>
<td>26,8 ± 7,8</td>
<td>66,2 ± 11,2</td>
<td>166 ± 7,8</td>
</tr>
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Procedures

All the subjects were evaluated just one time, individually. The adopted protocol consisted simultaneously of a dynamometer and electromyographic evaluation performed during the fatigue test. The EMG signals and force signals were detected with electromyography of 16 channels and with software of own device (EMG System of Brazil), with sampling frequency of each channel set at 1000 Hz, using a Pentium (200MHz) personal computer, with 64 MB RAM, endowed with an A/D converter.

Dynamometer Evaluation

For the dynamometer evaluation of the upper trapezius muscle the subjects remained seated while they performed a static contraction by the lifting of both shoulders. It is important to know that a belt was passed around both shoulders, but it was attached to the load cell just in the right side of the body. This load cell was instrumented with strain gauges and this cell was attached to the steel wire in the ground. Prior this procedure the load cell was calibrate and the correlation coefficients between the voltage output and known weights (range: 0 N to 50 N) were found to be 0,99.

Electromyography Evaluation

Surface electrodes (Ag/AgCl; with a diameter of 2,2 cm) were placed in a bipolar configuration on the right (R) side of the subjects on the upper trapezius region. The electrodes were positioned in parallel with the fibers of the muscles on procedures adopted previously by DE LUCA (1993). The norms about the adequate register of signals EMG have been observed rigorously. Some of them are: abrasion of the skin, cleanliness of the place using alcohol, electrodes placements and verification of the impedence (accepted when kept under 5kW), suggested for MERLETTI (1997) and recommended by the International Society of Electrophysiology and Kinesiology.

Protocol

The protocol adopted consisted in measuring three times the maximal voluntary contraction (MVC) for approximately 5 seconds, with a two minutes interval between trials. The highest value obtained was used to calculate the sub maximal level of calculated sub maximal level of 80% of the MVC for 35 seconds. The oscilloscope was used to provide a visual feedback. All subjects attended training sessions prior to data acquisition.

Processing of Analysis

For the analysis of signal EMG was used SAD32 System of acquisition of data (version 2.61.07mp, 2002)
The EMG signal were filtered using the digital filter Butterworth (high-pass 20 Hz, 5th order and low-pass 600Hz, 5th order). The EMG signal was recorded in 10 windows of 3 seconds each one and was analysed in the frequency domain using a fast Fourier Transform (FFT) to calculate median frequency (MF). Considering the restrictions of technique characteristics when there was comparison of EMG signals obtained through from data in different sessions (BASMAJIAN & DE LUCA, 1985), the highest value obtained during EMG test (MVC) was used to normalize the EMG signal.

The linear regression with 10 points (obtained from 10 windows), which supplied the coefficient of slope of a straight was done. The criterion of inclusion in this study was the correlation of the points with the straight line (r= 0.8).

The coefficient of slope of a straight of the MF has been used to measure the degree of fatigue muscular (ROY et al. 1990). However, according to CANDOTTI (1997), all the values of the curve of the MF, many times, are not represents the slope of the MF due to the fact of that since the fatigue process install itself from the beginning of the contraction muscle, can there is a great variability of the MF during the test. So, it was used coefficient of slope (α) of a straight in connecting the initial and final MF. Then, the coefficient of slope of a straight (equation 1) represents the index of located fatigue muscle that can to evaluate the behavior of the upper trapezius muscle during of the fatigue protocol.

\[
\alpha = \frac{MF_f - MF_i}{T_f - T_i}
\]  

(equation 1)

**Statistical Analysis**

The software SPSS 10.0 was adopted for data analysis. When the normalized data was confirmed (Levine test) simple t-test was applied to verify whether there was statistical difference between (1) the values of the contraction voluntary maximal (CVM); and (2) the coefficients of slope of a straight obtained between the initial and final points of MFs in the both groups, with and without pain in the upper trapezius. The U-test of Wilcoxon-Mann-Whitney was used in case of no-normal distributions. The level of significance adopted in this study was 0.05.

**RESULTS AND DISCUSSION**

The results of the maximum voluntary contraction (MVC) when submitted to simple t-test demonstrated that there was a significant difference (p=0.006) between groups with pain and without pain, being the average of the CVM of 30.11±10.33 kg for subjects with pain and 71.25±19.31 kg for subjects without pain.

The results of the fatigue protocol, using t-test showed that there was significant difference (p=0.044) between groups with pain and without pain, through the analysis of the inclination coefficient, which represents an index of muscular fatigue. This result indicates that the slope of a straight in the linear regression connecting the initial and final MF in the subjects with pain in the upper trapezius was significantly smaller (Figure 1).

According to CANDOTTI (1997) changes in EMG spectrum of the frequency can occur during sustained isometric contraction, decreasing MF. Also, this variation of signal EMG has been accepted for many researchers as an index of muscular fatigue that occurs during the sustained isometric contraction. In addition, at beginning of the contraction of 35 seconds of duration, the spectrum of the frequency showed a tendency to decrease in direction to lower frequencies. Thus, an indication of the pattern of fatigue process is supplied since the beginning of the contraction.

![Graph showing normalized median frequency over time](attachment:image.png)

**Figure 3** The coefficient of inclination of groups with pain and without pain in the upper trapezius.

It is usual to observe a compression of the EMG spectrum in direction to the lower frequencies during the fatigue protocol. Since this kind of behavior was verified in this study, it is speculated that was possible to evaluate the upper trapezius muscle during fatigue test for both groups, with and without pain muscle. However, the results demonstrated that when compared with the individuals of group without pain, the individuals of group with pain presented a greater capacity for to resist the fatigue, because they have presented smaller frequencies in the beginning of the fatigue induction test and values greatest in the end of this test. Therefore, the slope of the straight for group with pain is smaller than group without pain.

It is possible that people who suffer pain have pain threshold bigger than people without pain because they are used to live in this situation. When the body produces appropriated muscle contractions so that to prevent injuries, pain can represents an important function in order to protect the body, (GUYTON, 1997; MACHADO, 2003). This might explain the fact of group of individuals with pain, in comparison to CANDOTTI, was not able to perform its maximal force of the muscle in MVC because of the mechanism of protection to pain have been activated, preventing the maximal attempt of the demanded muscle.

ELFVIG, DEDERING & NÉMETH (2003), believe that the fact of people with pain have not performed its maximal force during MCV influenced in the results of the fatigue test when based on the result of MCV test, for example, 80% of the CVM. Since the individuals with pain have not performed its maximum force, which was represented through the MCV, the results of the present study are according with this information. This was confirmed through the values of the MCV, because the individuals of group with pain present values 50% smaller than the individuals without pain.

The upper trapezius has been related as being a muscle linked to the painful processes (MILERAD et al., 1991;
PRESSI, 2002) and according to MADELEINE et al (1999) it seems that there is a dynamic reorganization of EMG activity during pain, what it thought that it can there is a development of a new synergy, resulting in the minimization of the use of the painful muscles.

The located muscular fatigue has been pointed as related factor with the muscular problems that are associates to the chronic painful processes. Thus, it can be a sensitive tool to evaluate muscular pain (ROY et al, 1989). CLAMANN IN BINDER (1990) believes that the fatigue consists of a phenomenon of difficult definition, which can include more than just lack of force. The fatigue can have many forms and the intensity of each one of this is graduated from the imperceptible to the incapable. The fatigue is a continuous process that starts with the beginning of the neuromuscular activity and that it can causes changes in the electric activity, electric propagation, and excitation-contraction coupling and in the several elements of the contractile process. The neuromuscular fatigue is restricted by the physical and chemical alterations that occur in the motor unit.

In order to verify if the EMG analysis in the frequency domain may be used to evaluate differences between subjects with and without low-back pain several studies was developed. Several evidences about the merit of the EMG as useful tool to the diagnosis of low-back pain were demonstrated in literature (CANDOTTI, 1997). In this way, individuals that suffer low-back pain present a contractile capacity of muscles compromised and precocious myoelectric manifestations of fatigue muscular, when they are compared with the individuals without low-back pain (DIEEN et al, 1993). If is correct that the bigger slope of the straight line of the curve of MF represents a precocious myoelectric manifestation, the results obtained from the EMG evaluation were conflicting with this findings, due to the fact of the slope of the straight in the linear regression connecting the initial and final MF in the subjects with pain was significantly smaller and, consequently, a bigger value in the last window of the MF during of the fatigue test.

Thus, it is possible that the individuals with pain have not able to obtained its MCV, due to own pain and to the associated mechanisms of protection of pain. As consequence they not performed the fatigue protocol at 80% of the CVM, but at much smaller percentage and so, being more resistant to the fatigue.

In this present study was possible to identify groups with and without pain through results, but presenting an inverse relation between the fatigue and pain. Therefore, group with pain that would have presented a bigger inclination of the straight line of the MF, presented a lesser inclination, being more resistant to the fatigue than the individuals without pain. Consequently, these results are in conflict with the literature, since it have been registered that individuals with muscular pain tend to present higher indices of muscular fatigue, it means, individuals with pain are less resistant to the fatigue (DE LUCA, 1993). It is thought that the significant difference between groups of individuals with and without pain was a consequence of the incapacity of the individuals with pain to performed MVC and not as result of real differences in EMG signal that has relation with pain. Perhaps this conflicting result can be explained by the type of used protocol and by the motion of the individuals with pain have not performed MVC. Then it seems to be indicated an evaluation of fatigue based on the MVC.

CONCLUSION

The results of this study showed that the use of the surface EMG in the frequency domain (MF) was a useful tool to identify the subjects with and without pain in the upper trapezius. The results also demonstrated that the individuals with pain have not performed its maximal force during the MCV, being, consequently, more resistant to fatigue. Thus, it is speculated that if the subjects had performed its maximal force during the CVM during fatigue protocol, they could be less resistant to fatigue and to show bigger the slope of a straight of MF. The results of this study must be considered preliminary, because the number of sample was small (n=15) and because the individuals have not performed its maximal force during the CVM. Thus, it is intended to continue this study.

REFERENCES

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ANALYSIS OF FATIGUE MUSCLE IN THE UPPER TRAPEZIUS MUSCLE THROUGH THE ELECTROMYOGRAPHIC IN SUBJECTS WITH AND WITHOUT PAIN

ABSTRACT
The upper trapezius region suffers a lot of muscular pain or myofascial pain which can have its origin in the muscular fatigue when, many times, are submitted to intermittent contractions during the daily activities. The electromyography (EMG) has been used for to diagnosis the presence of the pain associated with the localized fatigue muscle. The aim of this study was to verify whether the use of the central frequency domain (MF) could identify subjects with and without pain in the upper trapezius. The experimental group was comprised for subjects with pain (10) and subjects without pain (5). Both groups were submitted to three times the maximal voluntary contraction (MVC) for 5 seconds, with a two minutes interval between trials and after more two minutes interval to fatigue test that consisted 35 seconds isometric contraction of the upper trapezius muscle, at 80% of the biggest MVC. The results showed significant difference (p = 0.044) between groups. The EMG analysis showed that the slope of a straight in the linear regression connecting the initial and final MF in the subjects with pain was significantly smaller.(p<0,05).

Key words: pain, fatigue, electromyography

ANÁLISE DE MÚSCULO DE FATIGUE DANS LE MUSCLE SUPÉRIEUR DE TRAPEZIUS

PAPÁR L'ELECTROMYOGRAPHIE DANS LES SUJETS AVEC ET SANS DOULER

RÉSUMÉ
La région supérieure de trapezius souffrent beaucoup de douleur musculaire ou de douleur myofascial qui peut avoir son origine dans la fatigue musculaire quand, beaucoup de fois, sont soumises aux contractions intermittentes pendant les activités quotidiennes. L'électromyographie (EMG) a été employée pour au diagnostic que la présence de la douleur a associé à la fatigue localisée musculaire. Le but de cette étude était de vérifier avec si l'utilisation de la surface EMG dans le domaine de fréquence (MF) pourrait identifier des sujets avec et sans douleur dans le trapezius supérieur. Le groupe expérimental a été constitué pour des sujets avec douleur (10) et des sujets sans douleur (5). Les deux groupes ont été soumis à trois fois la contraction volontaire maximale (MVC) pendant 5 secondes, avec un intervale de deux minutes entre les essais et après plus d'intervalle de deux minutes de fatigue l'essai à consisté contraction isométrique de 35 secondes du muscle supérieur du trapezius, à 80% du plus grand MVC. Les résultats ont montré la différence significative (p = 0.044) entre les groupes. L'analyse d'EMG a prouvé que la pente d'un droit dans la régression linéaire reliant le MF initial et final dans les sujets avec douleur était sensiblement plus petite (p<0,05).

Mots clés: douleur, fatigue, électromyographie

ANÁLISIS DE LA FATIGA MUSCULAR EN EL TRAPEZIO A TRAVÉS DE LA ELECTROMIOGRAFÍA EN INDIVIDUOS CON O SIN DOLOR

RESUMEN
El trapezoide, desde su posición superior, es muy acometido por el dolor muscular o miofascial, que pueden tener origen en la fatiga muscular cuando, muchas veces es sometido a las contracciones con intervalos durante las actividades diarias. La electromiografía (EMG) ha sido utilizada para diagnosticar la presencia del dolor asociada a la fatiga muscular localizada. El objetivo de este estudio ha sido verificar si la utilizacion (EMG) de la superficial, en el dominio de la frecuencia, permite identificar a los individuos con o sin dolor en el músculo trapezio superior. La muestra ha sido compuesta por quince individuos, divididos en dos grupos, uno con dolor (n=10) y otro sin dolor muscular (n=5). Los individuos de los dos grupos han sido sometidos a tres contracciones voluntarias máximas (CVM), con duración de 5 segundos cada uno y un intervalo de dos minutos. Los resultados han demostrado una diferencia significativa (p = 0.044) entre los grupos. Los individuos con dolor presentaron una menor inclinación en la recta obtenida a través de la regresión lineal entre el punto de principio y el final de la frecuencia media, mostrándose así más resistentes a la fatiga con relación al grupo de individuos sin dolor. Este resultado puede estar asociado al hecho de que individuos con dolor normalmente, no ejecutan su fuerza máxima, ya que actúan a los mecanismos de protección conectados al dolor, permaneciendo así en una contracción isométrica debajo de un 80% de la CVM. El nivel de significancia adoptado fue el de 0,05.

Palabras-clave: dolor, fatiga, electromiografía.

ANÁLISE DA FATIGA MUSCULAR NO TRAPEZIO ATRAVÉS DA ELECTROMIOGRAFIA EM INDIVIDUOS COM SEM DOR

RESUMO
O trapezio, em sua porção superior, é bastante acometido de dor muscular ou miofascial, que podem ter origem na fatiga muscular quando, muitas vezes, é submetido a contrações intermitentes durante as atividades diárias. A electromiografia (EMG) tem sido utilizada para diagnosticar a presença de dor associada a fatiga muscular localizada. O objetivo deste estudo foi verificar se a utilização da EMG de superfície, no domínio da frequência, permite identificar indivíduos com e sem dor no músculo trapezio superior. A amostra foi composta por quinze indivíduos, divididos em dois grupos, um com dor (n=10) e outro grupo sem dor muscular (n=5). Os indivíduos de ambos os grupos foram submetidos a três contrações voluntárias máximas (CVM), com duração de 5 segundos cada um, após um intervalo de dois minutos, a um teste de indução à fatiga, onde realizaram uma contração isométrica de 35 segundos a 80% da maior CVM. Os resultados demonstraram diferença significativa (p = 0.044) entre os grupos. Os indivíduos com dor, apresentaram uma menor inclinação na recta obtida pela regressão linear entre o ponto inicial e final da mediana da frequência, mostrando-se assim mais resistentes à fatiga em relação ao grupo de indivíduos sem dor. Este resultado pode estar associado ao fato de que indivíduos com dor, normalmente, não executam sua força máxima, pois ativam os mecanismos de proteção ligados à dor, permanecendo assim em uma contracção isométrica abaixo de 80% da CVM. O nível de significância adotado foi de 0,05.

Palavras-Chave: dor, fatiga, electromiografia.