30 - EVALUATION OF NEUROMUSCULAR ACTIVATION OF LUMBAR AND CERVICAL EXTENSION MUSCLE OF CYCLISTS WITH AND WITHOUT PAIN DURING DIFFERENT POSTURES AND CADENCES.

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INTRODUCTION

The practice of cycling has been generating big interest in the scientific mean. Factors related the pedaling efficiency and technique where extensively studied, making the inferior member muscle activation pattern and the action of the forces upon the pedal and the crank become well known. (TOO, 1990; GREGOR, 2000; MARSH & MARTIN, 1995; LI & CALDWELL, 1998) Some researches have dedicated to study the effect of cadence (GOTSHALL, BAUER & FAHRNER, 1996; BAUM & LI, 2003), the incidence of injury on the hip, knee and ankle, or even the presence of problems on perineum and the genital region of amateur and professional cyclists. (LOWE, SCHRADER & BREITENSTEIN, 2004; CALLAGHAN, 2005) In the mean time, literature has a lack of studies on the incidence of back and neck pain caused by cycling. Between the existent, the behavior of trunk muscles seem not to call the attention, as it should. (BURNETT et al., 2004; KOLEHMAINEN, HARMS-RINGDAHL & LANSHAMMART, 1989)

In other way, out of cycling ambient, much attention has been given to the high rating of individuals who present back pain, especially in lumbar region. Although its hard diagnosis, it is believed that the most cases it is generated by bad posture habits, and maintenance of incorrect positions in long periods. Several studies have investigated spine extension muscles behavior during specific activities and process of fatigue state establishment. (ROY, BONATO & KNAFLITZ, 1998; MARRAS, DAVIS & MARONITIS, 2001; DIEËN, SELEN & CHOLEWICKI, 2003)

There are no doubts that the researches made in cycling has contributed to the growth of the sport, by improving technique and possibility of creation of teaching methods of this activity. However, there is the necessity to acquire knowledge that allows reduction of the risk of spine injuries, making it a more comfortable sport. However, the aim of this study was to estimate a neuromuscular activation pattern for the lumbar muscle and cervical muscles of athletes with and without pain during the cycling practice.

MATERIAL AND METHODS

Amostra

The group experimental was comprised for the male cyclist with lumbar and cervical pain (n=5) and without pain (n=5). All athletes were informed about the procedures to be adopted and signed a consent form. Table I presents the mean values for stature, corporal mass, age and time of practical of the cycling for each group

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

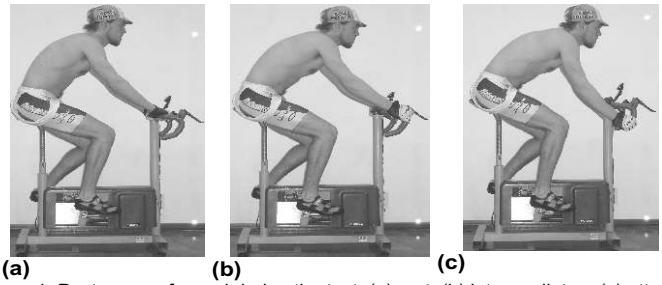
	practical (years)	age (years)	corporal mass (Kg)	stature (cm)
with pain	12,4±11,4	34,1±12,4	79,1±9,6	178,5±5,6
without pain	14,4±10,9	27,6±4,5	69,2±5,5	174,2±6,6

Assessment of neuromuscular activation

The subjects performed a test with the ergometer bicycles electromagnetic (FUNBEC). The original bank, handlebar and pedals were substituted by equipment of competition bicycles. For the verification of the cadences during the test it was added in the ergometer bicycles, a cycle computer and an electromagnetic sensor of kind of read switch. This sensor allowed the determination of the beginning and the end of each cycle of pedaling. The EMG signals were detected with electromyography of 16 channels connected to a Pentium (200MHz) personal computer, with 64 MB RAM, endowed with an A/D (EMG System of Brazil LTDA, São Paulo). The acquisition of the signals was done with software AqDados (Lynx Electronic Technology Ltda, São Paulo). Surface electrodes *(Ag/AgCl; with a diameter of* 2,2 cm) were placed bilaterally in a bipolar configuration on the eretor spinae muscles at L3 and on splenius capitis muscle. The location of L3 was estimated to be at level of the subjects´s umbilicus, and the erectos spinae muscle was located by moving approximately 3 cm laterally from the spinous process midline (ROY et al, 2003). Also, the location of splenius capitis muscle was estimated to be between the external occipital protuberance and the mastoid process. The reference electrode (land) was placed on the styloide process of ulna. The sampling frequency of each channel set at 1000 Hz. The norms about the adequate register of signals EMG have been observed rigorously. Some of then are: abrasion of the skin, cleanness of the place using alcohol, electrode placements and verification of the impedance (accepted when kept under 5KW), suggested for MERLETTI (2000) and recommended by the International Society of Electrophysiology and Kinesiology.

Protocol

Prior the test, the maximal voluntary contraction (MVC) was determined. It consisted of in measuring two times for each subject for approximately 5 seconds, with a two minutes interval between trials was. The maximal value of MVC was used as reference value for normalization. Before and after test, it was collected 15 seconds of resting with the erect column. The protocol consisted of pedaling at three positions (rest, intermediate and attack) and at two cadences (60 and 100rpm) at 150 W until the end of the test (Figure 1). The combination of these positions and cadences totalized 6 different situations (stages), which were tested individually during each 2 minutes. The duration of the test was about 15 minutes. The signal EMG of muscles was recorded during of last the 15 seconds of each stage. The time in each stage was considered some valid just when the cadences were stabilized. Thus, it did no have pause between the stages. The order of the stages was previously established and randomized.



(a) (b) (c)

Figure 1: Postures performed during the test: (a) rest, (b) intermediate e (c) attack.

Data Processing

For the acquisition of signal EMG was used the SAD32 System of acquisition of data (version 2.61.07mp, 2002) (www ufrgs.br/lmm). The signals EMG were analyzed corresponding to the 10 consecutive cycles of pedaling. The EMG signal was filtered using the digital filter: (1) high-pass 20 Hz, (2) rejected band 60,12 to 60,20 Hz). After, the signals were analyzed by the calculation of root mean square (RMS), during intervals of 40 ms (*Hamming*) (NEPTUNE, KAUTZ & HULL, 1997). For the normalization of the amplitude of signal, it was used as criterion the maximum value (peak) reached during the performance of CVM. Later, it was calculate the mean of the 10 pedaling cycles for each muscle, at each position and at each cadence. Prior, data EMG was submitted by qualitative analysis so that to do observation of the degree of muscular activation of each muscle, for each subjects and for each studied group, at three positions and at two cadences. After that, this data was submitted to statistical treatment.

Statistical Analysis

The statistical procedures were done with software SPSS 10.0. For the comparison between: (1) the groups with and without pain, (2) positions (rest, intermediate and attacked (3) cadences of 60 and 100rpm, the following statistical tests was adopted: (a) Test of Shapiro-Wilk to verify whether the data was normal; (b) Test of Mauchey to verify the sphericity of the data, it mean, whether the variation between the variables is similar and whether it happened in the same time; (c) Analysis for repeated measures, because it was about variables measured of same subjects during the long time and (d) the Test Pos Hoc - Bonferroni to verify where were it differences. The level of significance adopted was 0,05

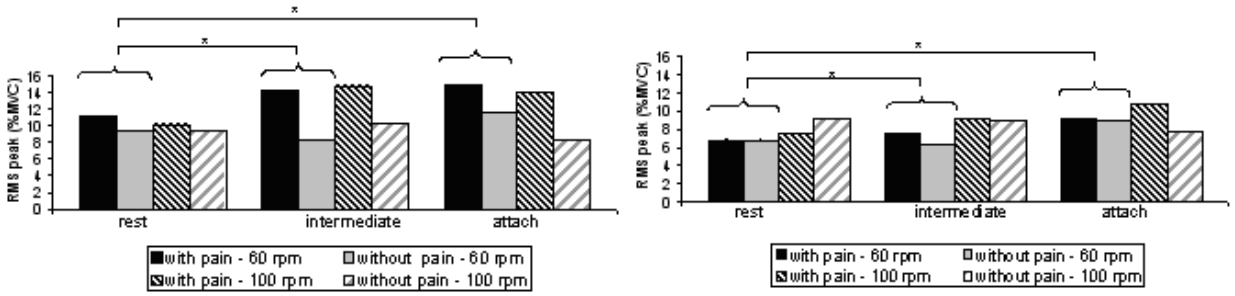
RESULTS

The results of this study are compared between: (1) the groups with and without pain, (2) positions (rest, intermediate and attack) and (3) at cadences 60 and 100 rpm.

The comparisons of the neuromuscular activation for lumbar muscles between the group (of with and without pain) no showed significant differences. Qualitatively, it was observed that the individuals with pain always had a higher value of the muscular activation than the individuals without pain, independent of the position and of the cadence. Results of the assessment of position no showed significant differences for lumbar muscles, independent of the group e of the cadence. Although the group with pain had higher neuromuscular activation than another one during all positions, when the groups were analyzed separately, it was observed that independent of posture, the level of activation was constant.

For the cervical muscles, the comparisons of the neuromuscular activation not showed significant difference for both the sides of its between the individuals with and without pain. Also, qualitatively, the individuals with pain always had higher values of neuromuscular activation than individuals without pain, independent of posture and cadence (Figure 2). On the other hand, the analyzes of mean values of RMS, when done the comparison between the postures, presented significant difference just for on the right side of cervical muscles, at cadence of 60 e 100 rpm. This difference can to be visualized between the rest position and intermediate position (p= 0,022).

Also, based on values of peak of RMS was found significant difference between postures at cadence of 60rpm. Again, this difference can to be visualized between rest position and intermediate position (p= 0,027) and between the rest position and attack position (p= 0,042) for on the left side of cervical muscle (Figure 2b). The right side of cervical muscle also presented significant difference at cadence of 60rpm, between the rest position and intermediate position (p=0,026) and between rest position and attack position (p=0,008) (Figure 2a). The comparison of the neuromuscular activation of postures, from value of peak, at cadence of 100rpm no showed significant difference.



The comparison between the cadence for lumbar and cervical muscles for both groups no showed significant difference between the cadence at 60 and 100rpm in none of three postures.

DISCUTION

The objective of this study was estimate a degree of muscular activity for the lumbar and cervical muscles of athlete with and without pain during positions used in the cycling practice. Thus, the behavior neuromuscular of the individuals was investigated in different positions (rest, intermediate and attack) and two cadences (60 and 100 rpm), by the analysis of the amplitude of EMG signal having as parameter the mean of peak values of the RMS normalized, and calculated for each group (with and without pain).

The differences between the groups with and without pain, for lumbar and cervical muscles there was no statistically significant. In addition, the difference between the cadences for the both muscles was statistically no significant. It is speculated that this results can be explained by the type of used protocol due to fact of it were not able to induce the located muscular fatigue. Previous studies about fatigue showed that there is a relation between increase of the muscular activation in individuals with pain and the neuromuscular fatigue (DIEËN, SELEN & CHOLEWICKI, 2003, CANDOTTI et al., 2004). In this way, the increase of value RMS has been associated to physiological and metabolic properties muscles (MASUDA et al., 1999). The authors have been suggested that to keeping an adequate muscular contraction during the effort demanded, it is necessary to compensate the negative influence that the accumulation of metabolic, as lactate, can to cause over capacity of contraction by new recruitment of motor units (MU).

However, in order to evaluate the process of neuromuscular fatigue, have been used the fatigue protocols. Yet, in this present study, since the objective was to evaluate the alterations in the muscular activation, which can to happen during the different positions and cadences, it was opted to use a protocol with constant load and with short time of duration. It is thought that an increase of the time of the test could cause the excessively great archives being consequently to impossible to be manipulated with the equipment accessible. Also, it was discussed that if the test had been performed for no athletes, the process of fatigue on the inferior members would install more fast become the analysis of the differences between the positions and cadences more difficult.

The differences between the positions was statistically significant for the cervical muscles (Figure 2), independent of presence of pain. For analyzes of mean values of RMS, the difference was on the right side of cervical muscles, in the

cadence of 60 rpm, between the position of rest and intermediate, but when analyzing the values of peak of the RMS, the difference significant was for both the sides, in 100 cadence 60 and rpm, between the position of rest and intermediate, and between the position of rest and attack. Thus, it is possible to suggest that the most of changes of spine during cycling are in cervical region (VEY MESTDAGH, 1998). The position of the cyclist can modify the curvature physiological of the spine and it depends basically of the adjustments that are done in the bicycle. It seems that the adjustments which cause more influence on position are the length of the frame and of the stem, the width of the handlebar and the point where this is fixed duo the fact of it to establish an degree of flexion of the trunk.

In this present study, it is thought that the distance between the frame and the stem was responsibility for increase of the flexion of the trunk causing a rectification of lumbar lordosis, increase of the kyphosis arc and a hyperextension of the cervical spine. Besides, during the constant movement of extension of the cervical column, is generated, a bigger moment of force (torque extension) induced for the weight of the head which can even triple in relation to the erect position (KOLEHMAINEN, HARMS-RINGDAHL & LANSHAMMART1989). Additionally, since the height of the bank is the only adjustment which can to be changed in the equipment used, the anthropometric differences between the subjects represented an aggravating factor for the analysis and comparison between the groups.

Furthermore, it is necessary to clarify that such differences were no systematic, it mean, in some moments it was significant for mean values of the RMS, only for the muscles of the right side, in the specific cadence at 60 rpm and between the rest position and intermediate, but in another moments it was significant for the values of peak of the RMS, for both the sides, at cadences of 60 and 100rpm and not only between the position of rest and intermediate, as also between the position of rest and attack. Thus, it is thought that pattern neuromuscular of cervical end lumbar muscles cannot be established.

CONCLUSION

In this study, the differences between the groups with and without pain, for lumbar and cervical muscles were no statistically significant. In addition, the comparison between the cadences showed the same results, independent of presence of pain or not. Since the differences between the positions was statistically significant for the cervical muscles, independent of presence of pain or not. It is speculated that the most of changes in the spine during cycling are in cervical region. However, analyzing with more details these differences, it is possible to observe that there was a great variability. Thus, it is thought that can not to be established a neuromuscular pattern during different positions and different cadences.

REFERENCES

BAUM, B.S. & LI, L. Lower extremity activies during cycling are influenced by load and frequency. **J. Electromyogr. Kinesiol.**, v.13, p.181-190, 2003.

BURNETT, A. et al. Spinal kinematics and trunk muscles activity in cyclists: a comparison between healthy controls and non-specific chronic low back pain subjects a pilot investigation. **Man. Ther.**, v.9, n.4, p.211-219, 2004.

CANDOTTI C T et al. EMG Signal behavior in human vastus lateralis, tibialis anterior and soleus muscles during fatigue. **Brazilian Journal of Biomechanics**, v.9, p.15-19. 2004.

CALLAGHAN, M.J. Lower body problems and injury in cycling. **J. Bod. Mov. Ther.**, v.9, p.226-236, 2005.

DIEËN, J.H.; SELEN, L.P.J. & CHOLEWICKI, J. Trunk muscle activation in low-back pain patients, an analysis of the literature. **J. Electromyogr. Kinesiol.**, v. 13, p.333-351, 2003.

GOTSHALL, R.W.; BAUER, T.A.; FAHRNER, S.L. Cycling cadence alters exercise hemodynamics. **Int. J. Sports Med.**, v.17, n.1, p.17-21, 1996.

GREGOR, R.J. Biomechanics of cycling. in GARRET, WE & KIRKENDALL, D.T. **Exercise and Sport Sciense.**, Lipincott Williams & Wilkins, Philadelphia, p. 515-537, 2000.

HÄKKINEN K, KOMI P V. Effects of fatigue and recovery on electromyophic and isometric force-and relaxation force- and relaxation-time characteristcs of human skeletal muscle. **Eur. J. Appl. Pyisiol**, v.55, p.588-596. 1986.

KOLEHMAINEN, I.; HARMS-RINGDAHL, K. & LANSHAMMART, H. Cervical spine positions and load moments during bicycling with different handlebar positions. **Clinical Biomechanics.**, v.4, p.105-110. 1989.

LI, L. & CALDWELL, G.E. Muscle coordination in cycling: effect of surface and posture. **J. Appl. Physiol.**, v.85, n.3, p.927-934, 1998.

LOWE, B.D; SCHRADER, S.M. & BREITENSTEIN, M.J. Effect of bicycle saddle designs on the perineum of the bicyclist. **Med. Sci. Sports Exerc.**, v.4, p.1055-1061, 2004.

MARRAS, W.S.; DAVIS, K.G. & MARONITIS, A.B. A non-MVC EMG normalization technique for the trunk musculature: Part 2. Validation and use to predict spinal loads. **J. Electromyogr. Kinesiol.**, v.11, p.11-18, 2001.

MARSH, A.P. & MARTIN, P.E. Effect of cycling experience, aerobic power, and power output on preferred and most economical cycling cadences. **Med. Sci. Sports Exerc.**, v.29, n.9, p.1225-1232, 1997.

MASUDA K et al. Changes in surface EMG parameters during static and dynamic fatiguing contractions. **J. Electromyogr.y and Kinesiol**. , v.9, p.39-46.1999

MERLETTI, R. Standards for reporting EMG data. **J. Electromiogr. Kinesiol.**, v.7, p.1-2. 2000.

MORITANI T, NAGATA A, MURO M, Eletromyographic manifestations of muscular fatigue, **Med Sci. Exercise.** v.14, n.3, p.198-202. 1982.

NEPTUNE, R.R.; KAUTZ, A.S. & HULL, M.L. The effect of pedaling rate on coordination in cycling. **J. Biomech.**, v.30, n.10, p. 1051-1058, 1997.

ROY, S.H.; BONATO, P. & KNAFLITZ, M. EMG assessment of back muscle function during cyclical lifting. **J. Electromyogr. Kinesiol.**,v.8, p.233-245, 1998.

ROY, S.H.; KELLER, T.S.; COLLOCA, C.J. Posture-dependent trunk extensor EMG activity during maximum isometric exertions in normal male and female subjects. **J. Electromiogr. Kinesiol.,** v.13, p. 469-476.2003.

TAKAISHI, T.; YASUDA, Y.; MORITANI, T. Neuromuscular fatigue during prolonged pedaling exercise at different pedaling rates. **Eur. J. Appl. Physiol**., v. 69, p. 154-158. 1994

TOO, D. Biomechanics of cycling and factors affecting performance. **Sports Med.**, v.10, n.5, p. 286-303, 1990.

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EVALUATION OF NEUROMUSCULAR ACTIVATION OF LUMBAR AND CERVICAL EXTENSION MUSCLE OF CYCLISTS WITH AND WITHOUT PAIN DURING DIFFERENT POSTURES AND CADENCES.

ABSTRACT

The posture adopted in cycling can to be related with presence of lumbar and cervical pain of individuals who have been practicing it, but few studies have been investigated a degree of muscular activity of this regions and of this modality. Thus, the aim of this study was estimate a neuromuscular activation pattern for lumbar and cervical muscles of cyclist with pain and without pain. EMG signals were recorded of 10 male cyclists, during test performed in ergometer bicycles electromagnetic, with constant load and with variations of position and cadence. Qualitatively, the results demonstrated higher neuromuscular activation of the individuals with pain than individuals without pain, independently of the position and of the cadence. However, It was not possible to establish a degree of muscular activity duo to the fact that such differences were no significant. The level of significance adopted was of 0,05.

Word-key: cycling, position, EMG.

ÉVALUATION D'ACTIVATION NEUROMUSCULAIRE DU MUSCLE LOMBAIRE ET CERVICAL DE PROLONGATION DES CYCLISTES AVEC ET SANS DOULEUR PENDANT DIFFÉRENTS MAINTIENS ET CADENCES.

RÉSUMÈ

Le maintien adopté dans le bidon de cycle à relier avec la présence de la douleur lombaire et cervicale des individus qui l'avaient pratiquée, mais peu d'études ont été étudiés un degré d'activité musculaire de ce des régions et de cette modalité. Ainsi, le but de cette étude était évaluation par modèle neuromusculaire d'activation pour les muscles lombaires et cervicaux du cycliste avec douleur et sans douleur. Des signaux d'EMG ont été enregistrés de 10 cyclistes masculins, pendant l'essai réalisé dans des bicyclettes d'ergomètre électromagnétiques, avec la charge constante et avec des variations de la position et de la cadence. Qualitativement, les résultats ont démontré une activation neuromusculaire plus élevée des individus avec douleur que des individus sans douleur, indépendamment de la position et de la cadence. Cependant, il n'était pas possible d'établir un degré de duo musculaire d'activité au fait que de telles différences n'étaient aucun significatif. Le niveau d'importance adopté était de 0.05.

Mots clés: cycle, position, EMG

AVALIACIÓN DE LA ACTIVACIÓN NEUROMUSCULAR DEL MÚSCULO LUMBAR Y CERVICAL DE LA EXTENSIÓN DE CICLISTAS CON Y SIN DOLOR DURANTE DIVERSAS POSTURAS Y CADENCIAS

RESUMEN

La postura adoptada en ciclismo que se relacionará con presencia del dolor lumbar y cervical de los individuos que la han estado practicando, solamente pocos estudios se ha investigado un grado de actividad muscular de este las regiones y de esta modalidad. Así, la puntería de este estudio era estimación al patrón neuromuscular de la activación para los músculos lumbares y cervicales del ciclista con dolor y sin dolor. Las señales del EMG fueron registradas de 10 ciclistas masculinos, durante la prueba realizada en cicloergómetro electromágnetico, con la carga constante y con variaciones de la posición y de la cadencia. Cualitativo, los resultados demostraron una activación neuromuscular más alta de los individuos con dolor que individuos sin dolor, independientemente de la posición y de la cadencia. Sin embargo, no era posible establecer un grado de dúo muscular de la actividad al hecho de que tales diferencias no eran ningún significativo. El nivel de la significación adoptado estaba de 0.05.

Palabra-llave: ciclismo, posición, EMG.

AVALIAÇÃO DA ATIVAÇÃO NEUROMUSCULAR DOS EXTENSORES LOMBARES E CERVICAIS DE CICLISTAS COM E SEM DOR EM DIFERENTES POSTURAS E CADÊNCIAS

RESUMO

A postura adotada no ciclismo pode estar relacionada à presença de dores nas costas e no pescoço de seus praticantes, porém, poucos estudos têm investigado o comportamento motor dos músculos destas regiões, nesta modalidade. Assim, o objetivo desta pesquisa foi verificar a existência de um padrão de ativação neuromuscular para os eretores lombares e cervicais de atletas com e sem dor, durante a prática do ciclismo. Foram coletados dados eletromiográficos de 10 ciclistas do sexo masculino, durante teste em cicloergômetro, com carga constante e variações de posição e cadência. Os resultados demonstraram qualitativamente, uma maior ativação neuromuscular dos indivíduos com dor, independentemente da postura e da cadência. Entretando, não foi possível estabelecer um padrão neuromuscular, pois tais diferenças não foram significativas. O nível de significância adotado foi de 0,05.

Palavras-chave: ciclismo, postura, EMG.