110 - THE EFFECT OF PASSIVE STRETCHING AFTER DIATHERMY BY SHORT WAVES AND CRYOTHERAPY ON HAMSTRINGS MUSCLE FLEXIBILITY ON MEN

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Introduction

Hamstrings muscle shortening is very common among humans. The application of a passive stretching program associated to others physiotherapeutic means have been mentioned in literature.

Stretching, physiotherapeutic maneuver is used to increase tissue mobility, thus improving the ROM, is one of the most applied techniques in physiotherapy on the enhancement of ROM[1,2].

According to BANDY et al. (1997)[3], muscular flexibility loss is revealed by the decrease in the capacity of a muscle to distort, which results in ROM reduction. Muscle shortening causes limitations to movements, increases wound risks and diminish motor performance capacity, and consequently it influences life quality[4,5]. Since one of the main goals of professionals on the physiotherapy field is to improve people's life quality, there's a great concern about doing research on techniques that may contribute to this quest.

Muscles are made up by myofibrils, elements that have the capacity of contraction, relaxation and stretching, and they constitute muscular cells called sarcomerers, which contain two contracted filament groups: actina (tenuous) e myosin (stiff). These filaments determine how the sarcomerers stretch themselves and thus, how they influence flexibility[6,7].

The stretching technique creates muscular processes, such as the muscular fibril length modifications, which in turn, results in an increase on the number of serial sarcomerers as well as deformations on tendons, fascias and ligaments, all of which enables an augment of the fibril's extensibility[8].

The muscle spindle is the main sensitive organ, as it monitors the speed and time of the stretching and detects the muscle length alterations[1].

Golgi's Tendinous Organs (GTO) are mechanic receptors that are sensitive to skeleton muscle contraction and show intense response when muscle tension increases suddenly, however they settle to a lower level of constant discharge in fractions of a second. When a low stretching force is applied to a muscle, Golgi's Organs shoots and inhibits the muscles tension, enabling the muscle to stretch[1,9].

One of the methods mostly used to increase ROM by the conservative approach is the passive stretch, which must be slowly applied until it reaches a discomforting limit that will give muscle relaxation and a good articulating-muscle system alignment. This method is the most diffused one because of its ease of applying and learning, its efficiency, its lesser wound risks and lesser energy consumption[10,11].

The muscle behavior analysis must take into account its structure, as for example its elastic and viscosity properties. Elasticity is a tissue property where it can withstand a deformation made by an external strain and return to its normal length at the end of the application of such force; viscosity is the property in which the deformation is directly proportional to the applied force, in other words, the more intense is the applied force the bigger is the muscle deformation. The ever enduring increases in the muscle length will result from an adaptive muscle remodeling and not simply from a viscoelastic deformation[12,13].

Among the many objectives of the stretching practice, is to avoid muscular spasm, for it keeps blood from flowing to the muscle that causes ischemic pain and further spasms, reduce muscle-articular wound risks, diminish or eliminate muscle nodules, as well as to improve blood flow and develop coordination[4,14].

There is still no consensus as to the time, frequency and series of stretching, when referring muscle flexibility enhancement. Nevertheless, it has been determined that the stretching is only effective when it's applied for 15 to 30 seconds rather than for six seconds[2,15].

Bandy and Irion (1994)[16] conducted a study with the aim to assess the necessary duration for the muscle to be sustained in a stretching position in order to increase flexibility; it was found that 30 seconds was enough to reach an effective stretching of the hamstring muscles. Such finding is in accordance with that presented in the studies made by Passos et al. (2005)[17] and by Rosário et al. (2004)[18].

Variation data on weekly frequency of muscular stretching exercises is hardly documented. There are still many diverging opinions and results concerning this issue, which ranges from 1 to 7 times a week. However, in order to improve flexibility, such stretching exercises must be done during three to five times a week[5,15].

According to the study made by Gondo and Costa (2004)[15], concerning series number needed to obtain maximum results on muscle stretching, most professionals point out that three series is the best number.

It's suggested by the literature that when stretching is aided by thermal resources (heating and cooling) its effects becomes more powerful.

Dutra et al., (2003)[6], have determined that when heating is added to stretching, it causes an increase on the movement range, which would consequently enhance the collagen's extensibility, decrease articular stiffness, alter the pain threshold, and finally promote muscle relaxation[1,9,19].

The use of cooling before stretching has also been recommended to increase flexibility. Although cooling is a daily procedure made in many clinics, it hasn't been objectively documented, which makes it even more uncertain and contradictory. Furthermore, while cooling enables a pain threshold increase and a nervous conduction decrease which favors the stretching effects, it also acts decreasing the conjunctive tissue extensibility, consequently minimizing the effect of this tissue[6,20].

This study was conducted based on the controversies mentioned in literature concerning the application of cryotherapy and diathermy through short waves as added to passive stretching. The study's objective was to analyze the influence of the above mentioned techniques over the hamstring muscles' flexibility, and to observe the acute and chronic effects.

Methodology

Screening of volunteers

A Short Version of the - IPAQ (*International Physical Activity Questionnaire*), which is used as a tool to evaluate the physical activity level of an individual, was applied along with the Extended Leg Raising Test of the dominant member. The muscular shortening was characterized by an angle smaller than 80º.

Henceforth, a selection of 30 male individuals who hadn't had any continuous physical activity for the previous 2 months, with an average age of 21,9 ± 1,87 years, height of 1,77 ± 0,05 m, weight of 73,2 ± 5,81 kg and body mass index (IMC)of 23,46 ± 1,52 kg/m².

Procedure

The selected individuals were randomly divided into three groups:

G1) 10 individuals were submitted to cryotherapy. These individuals underwent the ice cube test21. Cryotherapy (ground ice pack) was applied for 20 min, and then the individuals were placed and aligned in a decubital dorsal position with the hamstring muscle region being positioned over a wedged shaped pillow, as the ice pack placed on the thigh's hind region. Then 3 series of 30 seconds passive stretching, with a 30 seconds pause between each series, were applied.

G2) 10 individuals were submitted to the application of Continuous Short Waves for 20 min, then the individuals were placed and aligned in a decubital dorsal position with the hamstring muscle region being placed over a wedged shaped pillow as Short Waves plates were placed according to the longitudinal technique, with the use of a towel to avoid overheating. Then 3 series of 30 seconds passive stretching, with a 30 seconds pause between each series, were applied.

G3) 10 individuals were submitted to the static hamstring stretching only. Then 3 series of 30 seconds passive stretching, with a 30 seconds pause between each series, were applied (Control).

These procedures were made at the Orthopedic Clinic at UNILAVRAS. They were applied five times a week, for two weeks, totaling 10 stretching sessions.

The volunteers were measured by the universal goniometer, according to their maximum ROM hip flexion, carried out passively, before and after each stretching session, in order to evaluate the intervention's acute effects, while the chronic effects were evaluated through the first experiment measurement (1st day) and last experiment measurement (10th day).

Results

Figure 1 shows the average of the values obtained daily at the end of each session for the 30 volunteers, during ten days.

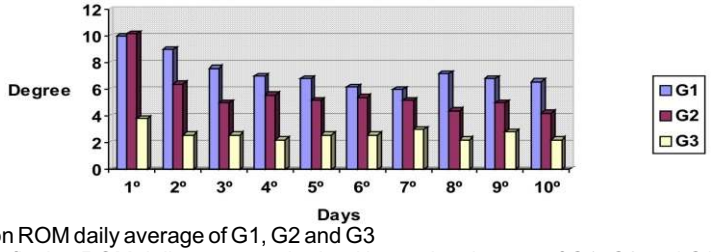


Figure 1: Hip flexion ROM daily average of G1, G2 and G3

Figure 2 shows hip flexion ROM daily average obtained by each volunteer of G1, G2 and G3, at the end of the study. It can be observed the influence of each technique applied on the hamstring muscle stretching, as the individual values were compared during the ten sessions.

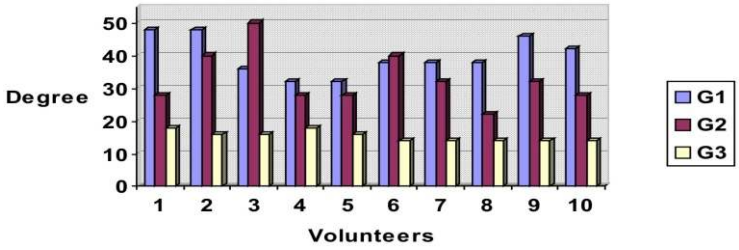


Figure 2: Hip flexion ROM obtained at the end of the study for each volunteer (G1, G2 and G3).

Figure 3 shows the degree average results of G1, G2 and G3, where the initial values refer to the ADM average on the first measurement before the procedures, while the final values refer to the ADM average after the ten-day evaluation. The difference between the final and initial values refers to the gain obtained at the end of the ten sessions. A significance level of 5% (p=?0, 05) was used in all cases.

	Initial	Final	Gain	*P Value*
G1	61,8º	101,6º	39,8º ± 5,9º	< 0,000
G2	59,8º	92,6º	32,8º ± 8,2º	< 0,000
G3	64,2º	80,0º	15,8º ± 2,2º	< 0,000

Figure 3: Hip flexion ROM degree average results, obtained at the end of the study, for G1, G2 and G3

Discussion

Acute Effects

Brasileiro et al. (2007)[22], analyzed the effects of cooling and heating over the hamstring muscle flexibility, and observed the acute and chronic effects. It was observed in this study, a significant difference between the three groups (p< 0, 01) in relation to the acute effect. There was a greater effectiveness for the group where the stretching was proceeded by cooling with ice packs. Knight (2000)[21], however, states that, as the temperature decreases, the conjunctive tissue stiffness increases but its extensibility decreases, making this tissue more resistant due to the greater muscular fiber viscosity. The attempt to strain the tissue extension, or even a slight stretching of the cooled tissues, can cause conjunctive tissue disrupture.

As mentioned above, Knight (2000)[21] reports that when cooling and stretching are applied together, it could be harmful in the case of desiring to enhance the conjunctive tissue extensibility, he also suggests that the tissue needs to be heated before stretching.

Although these conclusions are acceptable, cooling reduces even more the nervous conduction speed, and, thus, it reduces the fuse discharge as well as the pain stimulus, which enables the individual's endurance during the stretching maneuvers[22].

At the current study, it could be noticed, in relation to the acute effect , significantly higher gains on the hip flexion ROM for the group G1, which is in accordance to the studies carried out by Brasileiro et al. (2007)[22]. This result suggests that cryotherapy significatively decreases the fuse discharge frequency, thus, the musculature becomes more relaxed, which allows a more efficient stretching.

Chronic Effects

As to the chronic effects, Brasileiro et al. (2007)[22], did not observe any significant difference among the three experimental groups: group involving only stretching, group involving stretching proceeded by the application of cryotherapy and the group involving stretching proceeded by heating with diathermy through short waves. It can be inferred that the chronic effects were influenced neither by heating nor by cooling.

Dutra et al. (2003)[6], on the other hand, made analysis of how the thermal resources (cooling and heating) along with passive

stretching, influenced hamstrings muscle flexibility. All three groups: A (passive stretching), B (deep heating + passive stretching) and C (cooling + passive stretching) showed flexibility increase, being the results of thermal resources associated to stretching (groups B and C) more significant. Nevertheless, the association between deep heating and passive stretching had better results as to the flexibility gain.

Cooling is also described as being an influential factor on flexibility, as it decreases the nervous conduction speed it causes an alteration on the pain threshold, thus acting like an anesthetic, making it possible to efficiently promote muscle relaxation which will eventually benefit the stretching[6].

Muscle spindle performs an important role during the muscular stretching. Its stimulus increases the stretched muscle tension degree, thus limiting the muscle extensibility. Once the fuse discharge is reduced, so is the interference of this stimulus on the muscle tension. This fact is in agreement to earlier studies which showed that this muscle relaxation can be obtained by applying cryotherapy and suggested that the tension decrease would result from a muscular fuse discharge frequency reduction[22].

The present study checked the effectiveness of cryotherapy followed by passive stretching. This result can be explained by various factors, as the nervous conduction decrease that leads to analgesia and decreases the fuse discharge which consequently reduces muscular tension. Another factor that could influence positively, giving a better response to cryotherapy are the thermal receptors, that signal the changes in temperature, for the number of cooling receptors which are present in the organism is about eight times bigger than those of heating receptors, thus, the physiological effects caused by the use of cryotherapy are more intense when compared to the effects brought by diathermy through short waves.

It's been frequently observed that the pain limitation during stretching maneuvers precedes that of the tissue; thus, the subjective sensation of discomfort can reduce the maneuver effectiveness, minimizing the tissues changes. By applying cooling, there occurs a tolerance increase in relation to the maneuvers, which allows a greater stretching. Consequently the ice effects on the nervous conduction speed would prevail over the tissue extensibility alterations[22].

A prior knowledge about the influence of the several techniques to achieve a better flexibility is made necessary, so it will be possible to verify which of them can render greater benefits to the patient. Furthermore, according to this study, the procedure that applies stretching preceded by cryotherapy (G1) was the most effective one.

Conclusion

The current study has demonstrated that the acute and chronic effects of stretching were favored by the application of cryotherapy prior to passive stretching on the volunteers.

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THE EFFECT OF PASSIVE STRETCHING AFTER DIATHERMY BY SHORT WAVES AND CRYOTHERAPY ON HAMSTRINGS MUSCLE FLEXIBILITY ON MEN

ABSTRACT

Stretching causes both acute and chronic effects on musculature. The acute response to stretching has been attributed to two factors: neurophysiologic factors, due to a muscular resistance that is secondary to the reflexive activity and mechanic factor which

is associated to the muscular spindle activation. Another factor would be the decrease in viscoelasticity resulting from a stretching tolerance increase. The stretching chronic effect is related to the serial gain of both, sarcomerers and muscular length, enabling muscle to adapt to a new and longer length, as well as increasing the individual's ROM. The objective of the present study was to analyze the influence of diathermy by applying short waves and cryotherapy on hamstrings muscles flexibility and to observe its acute and chronic effects. Thirty volunteers insufficiently active, male, with hamstrings muscle shortening, aging between 18 and 25 years were selected. The individuals were randomly divided into three groups (n=10): Group 1) passive stretching preceded by cryotherapy; Group 2) passive stretching preceded by continuous short wave heating Group 3) passive stretching only (control). This procedure was made five days a week for two weeks, which totaled 10 sessions. All the volunteers were measured in relation to their maximum hip flexure before and after each stretching session, in order to evaluate the acute effects of the intervention, while the measurements made on the first and last day of the experiment, were used to evaluate the chronic effects. All three groups showed an increase on their hip flexion ROM for both, acute and chronic effects. G1 and G2 had a significant ROM increase in relation to G3, being the response of G1 the most significant of the three. Thus it can be concluded that both acute and chronic stretching effects can be enhanced by the application of cryotherapy before and after passive stretching.

KEY-WORDS: Stretching, cryotherapy, and diathermy.

L'EFFET DE L'ALLONGEMENT PASSIF APRÈS DIATHERMIE PAR PETITES ONDES ET CRYOTHÉRAPIE SUR LA FLEXIBILITÉ DES MUSCLES ISCHION- TIBIAUX EN HOMMES

RÉSUMÉ

L'allongement présente deux effets a la musculature, effets aigus et chroniques. La réponse aiguë à l'allongement est attribuée à deux facteurs : neurophysiologique, du a la résistance musculaire secondaire a l'activité réflexe, et mécanique, pour l'activation du fuseau musculaire. Autre explication c'est la diminution de la viscoélasticité, qui résulte dans augmentation de la tolérance a l'allongement. L'effet chronique de l'allongement est en relation avec l'augmentation de sarcomère en série et de la longueur musculaire, adaptant le muscle a un nouveau et plus grande longueur, augmentant l'ADM. L'objectif de cette étude a été analysé l'influence de la diathermie a travers les petites ondes et cryothérapie sur la flexibilité des muscles ischion-tibiaux observant les effets aigus et chroniques. Ils ont été sélectionnés 30 hommes, avec 18 et 25 ans, insuffisamment actifs, avec présence du raccourcissement des muscles ischion-tibiaux**.** Les individus ont été divisés aléatoirement en trois groupes (n=10) G1) Allongement passif précédé de la cryothérapie ; G2) Allongement passif précédé du diathermie continue ; G3) Allongement passif. La conduite a été appliquée cinq fois par semaine, pendant deux semaines. Les volontaires ont été mesurés en son ADM maximal de flexion de la hanche avant et après chaque session d'allongement pour évaluer les effets aigus de l'intervention, alors que pour évaluer les effets chroniques les mensurations ont été réalisées dans le premier et dernier jour de l'expérimentation. Les trois groupes ont augmenté de façon significative l'amplitude du mouvement de flexion de la hanche, tant dans les effets aigus comme dans les effets chroniques. Le G1 et G2 ont augmenté de façon significative l'ADM par apport le G3, étant que le G1 a obtenu une réponse plus significative entre les groupes. Il est conclu que les effets aigus et chroniques de l'allongement ont été favorisés par l'application de la cryothérapie avant l'allongement passif.

MOTS-CLES: Allongement, cryothérapie, diathermie.

EFECTO DE LA ELONGACIÓN PASIVA TRAS DIATERMIA POR ONDAS CORTAS Y CRIOTERAPIA EN LA FLEXIBILIDAD DE LOS MÚSCULOS ISQUIOTIBIALES EN HOMBRES.

RESUMEN

La elongación presenta dos efectos en la musculatura, efectos agudos y crónicos. La respuesta aguda a la elongación ha sido atribuída a dos factores: neurofisiológico, debido a resisténcia muscular secundária a la actividad refleja y mecánica por la activación del huso muscular. Otra explicación es la disminución de la viscoelasticidad, que resulta en el aumento de la tolerancia a la elongación. El efecto crónico de la elonagación está relacionado con la obtención de sarcómeros en serie y de longitud muscular, adaptando el músculo a una longitud nueva y mayor, aumentando la ADM. El objetivo de este estudio fue analizar la influencia de la diatermia por ondas cortas y da la crioterapia en la flexibilidad de los músculos isquiotibiales, observando los efectos agudos y crónicos. Se seleccionaron 30 voluntarios, hombres de 18 a 25 años, insuficientemente activos, com acortamiento de los músculos isquiotibiales. Los individuos fueron divididos aleatoriamente en tres grupos (n=10): G1) Elongación pasiva antecedida de la crioterapia; G2) Elongación pasiva antecedida de calentamiento por ondas cortas continuo; G3) Elongación pasiva. El procedimiento fue aplicado cinco veces por semana, durante dos semanas, totalizando 10 sesiones. Todos los voluntarios fueron medidos en su ADM máxima de flección de caderas, antes y después de cada sesión de elongación para evaluar los efectos agudos de la intervención, mientras que las mediciones realizadas en el primer y último día del experimento fueron utilizadas para evaluar los efectos crónicos. Los tres grupos aumentaron significativamente la ADM de flección de caderas, tanto en los efectos agudos como en los efectos crónicos. El G1 y G2 aumentaron significativamente la ADM en relación al G3, el G1 obtuvo una respuesta más significativa entre los grupos. Concluyó que los efectos agudos y crónicos de la elongación fueron favorecidos por la aplicación de la crioterapia antes de la elongación pasiva.

PALABRAS-CLAVES: Elongación, crioterapia, diatermia.

EFEITO DO ALONGAMENTO PASSIVO APÓS DIATERMIA POR ONDAS CURTAS E CRIOTERAPIA NA FLEXIBILIDADE DOS MÚSCULOS ISQUIOTIBIAIS EM HOMENS

RESUMO

O alongamento apresenta dois efeitos a musculatura, efeitos agudos e crônicos. A resposta aguda ao alongamento tem sido atribuída a dois fatores: neurofisiológico, devido a resistência muscular secundária a atividade reflexa e mecânico, pela ativação do fuso muscular. Outra explicação é a diminuição da viscoelasticidade, que resulta no aumento da tolerância ao alongamento. O efeito crônico do alongamento está relacionado ao ganho de sarcômeros em série e do comprimento muscular, adaptando o músculo a um novo e maior comprimento, aumentando a ADM do indivíduo. O objetivo deste estudo foi analisar a influência da diatermia por ondas curtas e crioterapia sobre a flexibilidade dos músculos isquiotibiais, observando os efeitos agudos e crônicos. Foram selecionados 30 voluntários do sexo masculino, com idade entre 18 a 25 anos, insuficientemente ativos, com presença de encurtamento dos músculos isquiotibiais. Os indivíduos foram divididos aleatoriamente em três grupos (n=10): G1) Alongamento passivo precedido da aplicação da crioterapia; G2) Alongamento passivo precedido de aquecimento por ondas curtas contínuo; G3) Alongamento passivo (controle). O procedimento foi aplicado cinco vezes por semana, durante duas semanas, totalizando 10 sessões. Todos os voluntários foram mensurados em sua ADM máxima de flexão de quadril, antes e após cada sessão de alongamento para avaliar os efeitos agudos da intervenção, enquanto que as mensurações realizadas no primeiro e no último dia do experimento, foram utilizadas para avaliar os efeitos crônicos. Os três grupos aumentaram significativamente a ADM de flexão de quadril, tanto nos efeitos agudos como nos efeitos crônicos. O G1 e G2 aumentaram significativamente a ADM em relação ao G3, tendo o G1 obtido uma resposta mais significativa entre os grupos. Concluiu-se que os efeitos agudos e crônicos do alongamento foram favorecidos pela aplicação da crioterapia antes do alongamento passivo.

PALAVRAS-CHAVES: Alongamento, crioterapia, diatermia.