



Effects of three protocols of hamstring muscle stretching and paravertebral lumbar¹

Efeitos de três protocolos de alongamento dos músculos isquiotibiais e paravertebrais lombares

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Abstract

Introduction: the muscle stretching is widely used to gain extensibility and flexibility, it is important to know the duration of these effects, after return to usual activity level. Thus, the aim of this study was to analyze the effect of three protocols of hamstring and paravertebral lumbar muscles stretching, and joint flexibility and muscle extensibility after six weeks. **Methods:** participants were 40 volunteers, with limited hamstring extensibility, randomized into three groups: active stretching static (n = 14), proprioceptive

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neuromuscular facilitation (n = 14) and kinesiostretching (n = 12). The protocol was divided into 3 stages: the 1st control (six weeks), the 2nd application of stretch (six weeks) and the 3rd follow-up (eight weeks). The project was approved by the Ethics Committee on Human Research Unioeste, under protocol number 25536/2008. Four evaluations were conducted with board coupled to a system and goniometry and Well's bench, distributed at the beginning and end of each step. Data were analyzed with repeated measures ANOVA, and one-way, with a significance level of 5%. **Results:** there was no significant difference for the three groups in the control stage. There were significant differences in the three protocols in the stage of stretching. After follow-up stage, there was significant difference in the ratings to the board goniometry, and there was no difference in the Well's Bench. **Conclusion:** the three techniques promoted significant gain in extensibility and flexibility, extensibility was not maintained after the follow-up stage, and the flexibility of the posterior chain continued gains.

Keywords: Skeletal muscle. Articular range of motion. Muscle stretching exercises.

Resumo

Introdução: o alongamento muscular é muito utilizado para ganho de extensibilidade e flexibilidade, sendo importante conhecer o tempo de duração destes efeitos, após o retorno ao nível de atividade usual. Assim, o objetivo do presente estudo foi analisar o efeito de três protocolos de alongamento dos músculos isquiotibiais e musculatura paravertebral lombar, quanto à flexibilidade articular e extensibilidade muscular, após seis semanas de alongamento. **Métodos:** participaram 40 voluntários, com extensibilidade de isquiotibiais limitada, aleatorizados em três grupos: alongamento ativo estático (n = 14), facilitação neuromuscular proprioceptiva (n = 14) e cinesioalongamento (n = 12). O protocolo foi dividido em 3 etapas: a 1^a controle (seis semanas), a 2^a aplicação do alongamento (seis semanas) e a 3^a seguimento (oito semanas). O projeto foi aprovado pelo Comitê de Ética em Pesquisa em Humanos da Unioeste, sob protocolo de número 25536/2008. Foram realizadas quatro avaliações com prancha acoplada a um sistema de goniometria e banco de Wells; distribuídas no início e no fim de cada etapa. Os dados foram analisados com ANOVA medidas repetidas e unidirecional, com nível de significância de 5%. **Resultados:** não houve diferença significativa para os três grupos na etapa controle. Houve diferença significativa nos três protocolos na etapa de alongamento. Após a etapa de seguimento, houve diferença significativa para as avaliações na prancha de goniometria, e não houve diferença no banco de Wells. **Conclusão:** as três técnicas promoveram ganho significativo da extensibilidade e flexibilidade; a extensibilidade não foi mantida após a etapa de seguimento, e a flexibilidade da cadeia posterior manteve os ganhos.

Palavras-chave: Músculo esquelético. Flexibilidade articular. Exercícios de alongamento muscular.

Introduction

Stretching is often used with the aim of promoting accruals in range of motion (ROM) in different population types (1, 2, 3, 4, 5, 6, 7), favoring the improvement of the daily life functions and injuries recovering (8, 9), despite controversies with respect to physical performance and pain relief after its application (10, 11, 12, 13, 14, 15). The increasing in ROM is possible because the stretching techniques influence muscle extensibility and joint flexibility (16, 17). Extensibility is the ability of muscle to extend, stretching the muscular fibers, increasing muscle

length. Flexibility is the ability to move one or more joints using the entire ROM (2, 18).

Skeletal muscle responds to mechanical stimuli, remodeling to adapt itself to the new demands. Therefore, the skeletal musculature is known for its high adaptive capacity varying the fiber type, size and metabolism, so as to allow a great strength generation, speed and therefore power (19, 20, 21). In the same way that the stimulus generates tissue adaptations, interruption or significant reduction of overload, leads to a partial or complete reduction of adaptations generated, which describes the training reversibility principle (22).

There is an extensive variety of stretching techniques, and three of them are static, the proprioceptive neuromuscular facilitation (PNF) and kinesiostretching. The static consists in fending the origin of the muscular insertion, applying a controlled external force in the direction, speed, intensity and duration (1, 23). The PNF combines static stretching, contraction and isometric relaxation, followed by another static stretching (24, 25). The kinesiostretching is a technique that combines three moments of stretching, being static, active, passive stretching and PNF, respectively (26).

As important as to evaluate which of the interventions provides the best results is to know what the duration of these effects, after individuals return to their usual level of activity in short or long term (weeks after withdrawal of the stimulus of muscle stretch). This knowledge has an impact on physical therapy goals in the medium and long term, enabling the therapist to schedule a treatment that produces good results both during and after its application. So, the aim of this study was to analyze and compare the effect of three stretching protocols in the hamstring muscles and lumbar paraspinal musculature, as the joint flexibility and muscle extensibility, right after six weeks of stretching protocol, and eight weeks of follow-up.

Methods

Sample characterization and groups division

The research was characterized as a randomized clinical trial, evaluator-blinded, being approved by the Ethics Committee in Human Research of the State University of West Paraná (Unioeste), under the protocol number 25536/2008. The sample consisted of 40 volunteers, 5 men and 35 women, aged between 18 and 30 years (20.2 ± 2.74 years), with no differences between groups ($p > 0.05$), academics from various courses of the Unioeste, which received verbal invitation to participate in the study. Were included the individuals who reported no musculoskeletal disease that compromised the procedures performance, and that did not exceed 160° of knee extension in active motion with the hip at 90° of flexion. Subjects who changed their usual pre-treatment physical activities (regardless of being or not sedentary) during the survey period, and/or lacked any stretching session, without replacing it, were excluded.

All volunteers had clarification of the experimental procedures and also the muscular discomfort during stretching application, being this, the reference for the movement end. The subjects who agreed with the intervention signed a consent form.

Participants were randomly assigned (blinded draw), by strata of joint range of 10^{th} in active stretching static groups (AS) ($n = 14$), proprioceptive neuromuscular facilitation (PNF) ($n = 14$) and kinesiostretching (KS) ($n = 12$). The stretching sessions were preceded by five minutes of warm-up in bicycle ergometer, as the procedure reduces the risk of injury during the application of muscle stretching (24).

Assessment Moments

The study was divided into three stages, having the first and second stages two to six weeks, and the last, eight weeks (Figure 1). At baseline, the subjects underwent 1st assessment and after six weeks without any intervention, subjects were reassessed (2nd assessment), and the resulting data were used as controls in the study (Stage 1 – Control).

After the 2nd assessment the intervention protocols were initiated, being composed of three weekly sessions. After six weeks, the subjects went through the 3rd assessment (Stage 2 – Stretching). After eight weeks of Stage Two completion, the subjects were reassessed (4th assessment) to check the durability of the results (Stage 3 – Follow-up). All evaluations were performed by a single reviewer without knowledge of which group the assessed subject took part.

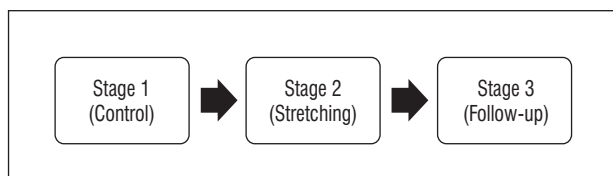


Figure 1 - Schematic representation of the study stages

Source: Research data.

Assessment Tools

For measuring the hamstring muscles extensibility a goniometry board adaptation developed by Brasileiro, Faria and Queiroz (18) was used. The

subject was positioned in dorsal decubitus with the right hip sustained at 90° of flexion, with the opposite limb extended. Fixation was ensured by bands in the chest, pelvis and thighs. The evaluator performed the passive extension of the right knee until the perception of motion resistance, and checked the obtained angle. The procedure was repeated on the left lower limb.

To measure the flexibility of the posterior chain the Wells' Bench (27) was used. The subject was positioned sitting with knee extension and feet slightly apart, in full contact with the front face of the bench. The volunteer was instructed to move the scalimeter with overlapping hands, through a trunk flexion to the maximum possible keeping knees and elbows extended.

Static active stretching protocol

In lumbar paraspinal stretching the volunteer, in dorsal decubitus, was instructed to flex the knees and hips, bringing the knees against the chest, also flexing the head. This position was kept for 32s.

In the hamstrings stretching the volunteer, on orthostatic position, was instructed to place the right heel on a stretcher, keeping plantar dorsiflexion and extension of the right knee. It was permitted slight bending to the knee of the opposite limb. Then the volunteer bent the trunk forward, with the arms extended along the right leg until he/she feel slight discomfort of muscle stretch (2) for 32s. The procedure was repeated on the left lower limb.

PNF protocol

To stretch the paraspinal musculature the volunteer positioned himself sitting at 90° of hip flexion and knees semiflexion, trunk flexed toward the feet to the point of slight discomfort. The volunteer was instructed to perform maximal strength to extend the trunk, for five seconds, against resistance. Then, the individual relaxed and had the trunk directed to a new position of flexion, holding for 32s.

For the hamstrings, the participant was positioned in dorsal decubitus and had the left thigh stabilized by the researcher. The therapist passively flexed the volunteer right hip, keeping the knee extended, to the position where the volunteer related discomfort,

and supported the individual right leg on his shoulder. The participant performed maximal strength to extend the hip, for 5s against resistance (25). At the end of the 5s, the volunteer relaxed the muscles and had the hip passively flexed again, up to mention a new discomfort (25, 28). The limb was kept at that point for 32s. The maneuver was repeated in the left lower limb.

Kinesiostretching protocol

On the lumbar paraspinal muscles Stretching, the individual sat in triple flexion and shifted his torso forward. This procedure was maintained for 8s and repeated three times. The difference between each repetition is that in the first one the volunteer made the move to its limit and the therapist only stabilized for 8s. In the second, the therapist pulled lightly the participant during 8s (both positions are adaptations of static stretching). In the last repetition the individual was pulled for the same period, and completed time, professional requested that the subject extended the trunk during 8s, being prevented by him, producing isometric contraction. At the end of this isometric interval the volunteer relaxed and the therapist pulled him lightly, for over 8s (26) (adaptation of PNF). In total, the patient underwent 32s stretching, time similar to that used in the other groups.

The hamstring kinesiostretching was performed with the subject seated, with extension of the dominant lower limb, associated with flexion and external rotation of the contralateral limb. The upper non-dominant limb was pulled by the therapist during the exercise. The volunteer was instructed to move the torso forward, also performing ankle dorsiflexion and head flexion. This procedure was maintained for 8s and repeated three times. As in paraspinal, the first repetition of hamstring kinesiostretching was performed with the participant moving to its limit and the professional only stabilizing him, and the second repetition was performed with traction, having each of the postures duration of 8s. In the third repetition volunteer was pulled for the same time, and after completing the time, the professional requested that the individual pulled him in an attempt to extend the trunk for 8s, being prevented by him. Then, the volunteer relaxed and the therapist pulled him lightly for over 8s (26). The protocol was repeated in the lower non-dominant limb.

Statistical analysis

The data were presented by descriptive statistics (average and standard deviation) and analyzed by inferential statistics, using ANOVA repeated measures (for intragroup comparison) and one-way (for comparison between groups). In all cases the significance level was $p < 0.05$.

Results

Hamstrings extensibility

In the evaluation with the goniometric board was possible to observe that in Stage 1 there was no gain in extensibility ($p > 0.05$). Fact occurred after stretching protocols application in Stage 2, glimpsed by significant differences between EV3 either with EV1 or EV2 ($p < 0.05$). In Stage 3, follow-up, there was a significant difference in muscle extensibility, when comparing EV4 with EV3, indicating a loss in

ROM. Also in KS, there was a difference between EV2 and EV4, indicating that the values showed at the beginning of the protocols application have not been reproduced (Table 1). In the comparisons between groups were no significant differences when evaluated at different time points ($p > 0.05$).

Flexibility of the posterior chain

In Wells' Bench evaluation for the posterior chain flexibility, once again we observed that in Stage 1 there was no flexibility gain ($p > 0.05$). This occurred after the stretching protocols application in Stage 2, glimpsed by significant differences between EV3 with both EV1 and EV2 ($p < 0.05$). In Stage 3, follow-up, there was a significant difference in flexibility, comparing EV4 with EV1, and except for AS, difference also between EV4 and EV2 (Table 2), showing gains in the long term for both interventions (PNF and KS) (Table 1). Similar to the assessment performed with the board, there were no differences between groups ($p > 0.05$).

Table 1 - Assessment results obtained with the goniometric board in degrees, values presented as averages and standard deviation for different groups in different time points (EV)

	AV1	AV2	AV3	AV4
AE	141.30 ± 7.42	140.60 ± 6.05	155.10 ± 6.11*●	143.70 ± 6.49○
FNP	142.90 ± 8.62	141.80 ± 7.24	158.70 ± 8.47*●	144.80 ± 5.17○
CA	141.60 ± 10.72	138.10 ± 8.01	154.10 ± 7.76*●	143.90 ± 5.63 ○●

Note: *: Significant difference when comparing with EV1 ($p < 0.05$); ●: Significant difference when comparing with EV2 ($p < 0.05$); ○: Significant difference when comparing with EV3 ($p < 0.05$).

Source: Research data.

Table 2 - Results of the assessment with the Wells' Bench, in centimeters, values presented as mean and standard deviation for different groups in different time points (EV)

	EV1	EV2	EV3	EV4
AS	19.46 ± 10.90	20.25 ± 10.43	25.79 ± 10.28*●	23.50 ± 10.89*
PNF	17.07 ± 9.70	16.64 ± 9.06	24.04 ± 8.11*●	21.86 ± 8.32*●
KS	21.92 ± 8.44	22.83 ± 8.85	29.42 ± 7.06*●	27.38 ± 7.07*●

Note: *: Significant difference when comparing with EV1 ($p < 0.05$); ●: Significant difference when comparing with EV2 ($p < 0.05$).

Source: Research data.

Discussion

The achievement of stretching provided significant gains in muscle flexibility and extensibility, regardless of the technique employed. Although the characteristics of each protocol, the three techniques were kept for the same time interval for it corresponds to the sum of the four 8s stretches of kinesiostretching, ie, 32s. The time of sustained stretching of 30s is well described as efficient for a ROM gain (9, 29).

Gama et al. (25) also obtained extensibility gains, using hamstring muscles PNF stretching for two weeks, regardless of the repetitions number (one, three or six maneuvers of 30s). In the study by Batista et al. (30) were 34 volunteers performed static stretching (hamstrings) for four weeks (2 sessions/week, 7 repetitions of 1 min). The protocol resulted in ROM increase. Agreeing, Decoster et al. (2) found hamstrings increased extensibility after static stretching for 3 weeks (3 sessions/week), and each session consisted of three sets of 30s. França et al. (5), using a program of paraspinal and hamstring muscle stretching for 6 weeks, observed improvement in pain and disability in low back pain subjects. Locks et al. (6) also observed that six weeks were sufficient to produce improvement in functional performance in elderly.

Besides increasing the number of sarcomeres, the largest muscle extensibility is possible because of adjustments in the titin length. The stretching recruits titin additional segments that are "bent" or connected to myosin filament, enabling an increase in muscle length (31).

During stretching, the tension is transmitted to the muscle fiber by their surrounding connective tissue (32), therefore, the increase in extensibility involves adjustments in the perimysium and tendon, which under stretching shows a reduction in viscosity and stiffness (33).

In the present study it was defined as a long-term period the 8 weeks follow-up, in which volunteers were monitored after the end of the stretching protocols, in this period the hamstring muscles extensibility, was not maintained. Similar to that observed by Lima et al. (34) and Youdas et al. (35), for the hamstrings and triceps surae stretchings, respectively, at 6 weeks protocols, with return to baseline around the day 4. In the present study, it is assumed that muscular adaptations occurred, however, due to the long follow-up period, the mechanical overload provided

by stretching was removed, and the adjustments were not maintained.

Regarding posterior chain flexibility, in all three techniques applied, it was maintained after cessation of stretching. It is suggested that these results were possible because the stretching of both paraspinal muscles and hamstrings, favor the posterior chain flexibilization, ie, besides the muscle segment, also fascias, ligaments and capsules. Despite the flexibility gain found in the posterior chain occur in all the three protocols, the KS and PNF groups had a more important performance, because they showed significant differences between the 2nd and 4th assessment on the Wells' Bench. In other words, despite the static stretching does not show difference between the 3rd and 4th assessment, the results presented in the follow-up phase are similar to pre-stretch values. Even with some differences in intragroup comparisons, as the mentioned above, the intergroups comparison showed no significant difference in any of the instruments, indicating that no stretching protocol was more effective than the other.

This research was limited to analyze the difference between the protocols after application and after a follow-up in young healthy subjects. Future research may examine other stretching methods, with greater monitoring during the follow-up stage, analyzing also volunteers with different ages and associated diseases, once that the mechanisms responsible for muscle tropism modify (20).

It is concluded that all three protocols promoted hamstring muscles extensibility gains and posterior chain flexibility. After the follow-up phase the extensibility was not maintained, and the posterior chain flexibility kept the gains in all three stretching protocols.

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