

CINEMATIC ANALYSIS DURING A KICK OF TAEKWONDO AFTER PASSIVE STATIC STRETCHING EXERCISE

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The purpose of this study was to investigate if the range of motion (ROM) of knee extension during a Taekwondo kick could be influenced by a single session of passive static stretching. Black belt Taekwondo recreational athletes (n=12) with no recent injury of the lower limbs were submitted to passive static stretching. The knee extension ROM during the kick and the passive static ROM of the hamstring muscle were analysed before and after the stretching. The stretching caused an increase in joint ROM, but did not result in differences of the knee extension ROM during the Taekwondo kick.

KEY-WORDS: Knee extension angle, passive static stretching, range of motion, Taekwondo.

INTRODUCTION:

Increase of the range of motion (ROM) is an expected response when different techniques of stretching are used. The acute response to stretching has been attributed to viscoelastic properties of the muscle-tendon unit (MTU) (Taylor et al., 1990) and to changes in stretch tolerance (Magnusson et al., 1998). In sports practice, passive static stretching is widely used for being considered easy to execute and because of the low risk to exceed the extensibility limits of the tissues involved (Kim, 1998). However, in several sports the demand of flexibility performance is predominantly dynamic in nature.

In Taekwondo, great ROM in the hip and knee joint are necessary. Therefore, the stiffness of antagonistic muscles can result in an increased passive resistance, that may influence the performance of the kicks. According to Shrier (2004), the stretching exercise can reduce MTU's stiffness by transient changes of viscoelastic properties, allowing larger ROM to be reached without changes of muscular force level. But it is not clear, if stretching exercises influence the cinematic parameters (knee extension angle) during a complex motor task such as a Taekwondo kick. Therefore, the purpose of this study was to investigate if the ROM of knee extension during the Taekwondo kick ("Ap Tchagui") could be influenced by a single session of passive static stretching.

METHODS:

Twelve male black belt Taekwondo recreational athletes participated (age: $26,58 \pm 5,23$ yr, height: $1,795 \pm 0,09$ cm, weight: $74,14 \pm 14,10$ kg) in this study. The athletes should not have recent injuries in the hip and knee joints. All procedures were explained to the volunteers, who signed a term of free and informed consent. During a familiarization session the volunteers were informed about the execution of the kick technique and the procedure of the flexibility test including the registration of individual setups of the test equipment.

Before the testing session, the individuals performed a 4-min standardized warm-up program consisting of rope skippings, lateral and front "jumping jacks" (callisthenic exercises).

The testing design was composed by the following steps: a) assessment of the maximum ROM and the knee extension ROM during the kick technique; b) flexibility training; c) assessment of the maximum ROM and the knee extension ROM during the kick technique.

The knee extension ROM of the frontal Taekwondo kick ("Ap tchagui") was registered in the sagittal plane by a digital video camera (BASLER A602f-2) with 200 Hz. The images were

acquired and analyzed using the software SIMI Motion 7.2 (SIMI Reality Motion Systems GmbH, Germany). For better visualization, joints (fifth metatarsus and lateral condyle of the knee bone landmarks) were marked with reflexive ribbons.

Starting from the initial position (FIG. 1A) the athlete's task was to touch the target with the distal part of the foot reaching a maximum height (FIG.1B). Three kick movements were executed subsequently by both limbs with the highest possible speed.

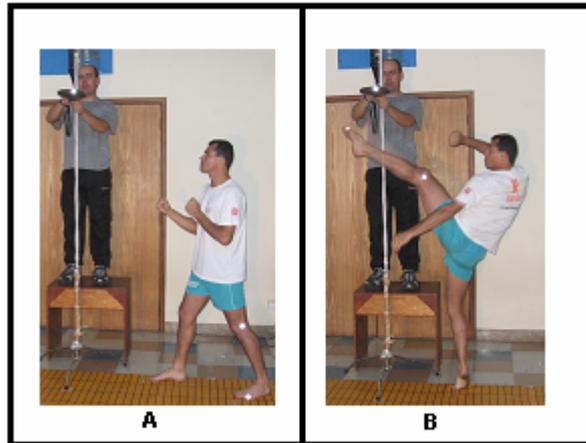


Figure 1 – Initial (A) and final position (B) of "Ap tchagui" Taekwondo kick.

The active knee extension test (AKET) was used to assess hamstring flexibility (Netto et al., 2003). The subjects were located in supine position with the hip flexed at 120° as shown in FIG. 2. Starting at the initial position, the subject performed the active knee extension slowly and progressively until maximum ROM, which was maintained for two seconds. The maximal flexion angle was measured by a flexometer (Leighton, model. 01146). This procedure was performed three times before and after the flexibility training.



Figure 2 - Supine position with the hip flexed at 120°.

The flexibility training consisted of a single session of passive static stretching. Stretches were held for 20 seconds and repeated four times. The training was executed at the same testing apparatus with only one lower limb that was determined randomly. The stretched lower limb was considered as the experimental group and the other lower limb as control group. In order to compare the effect of the stretching procedure paired T-tests were performed comparing the means of ROM at the active knee extension test (FIG. 2) and the knee extension angle during the "Ap Tchagui" kick before and after the passive static stretching.

RESULTS

A significant difference ($p < 0.05$) was found between the maximum ROM mean values measured in the AKET for the experimental group (FIG.3). However, no significant differences could be found between the means of the knee extension ROM during the execution of the kick technique for both groups (FIG.4).

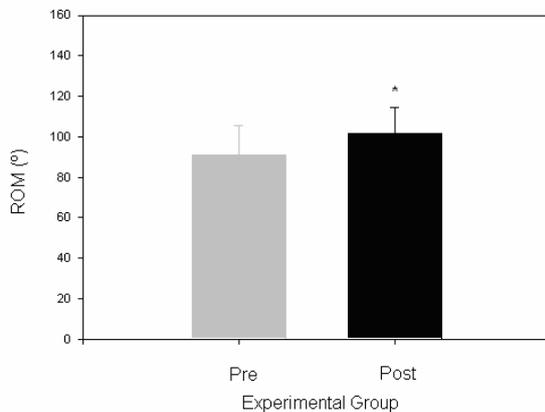


Figure 3 – Mean \pm SD. Maximum ROM in pre and post-stretching (* significantly different from pre-stretching).

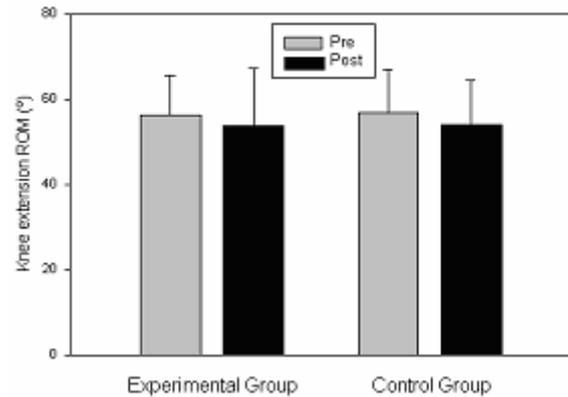


Figure 4 - Mean \pm SD. Knee extension ROM during the kick for the experimental (pre and post-stretching) and control group.

DISCUSSION

The results of this study showed that the applied flexibility training was sufficient to increase maximum ROM significantly, what is in accordance with other studies (Fantini et al., 2006). According to Taylor et al. (1990) the increase of maximum ROM is related to the decrease of passive resistance of the MTU to stretch. A reduction in the passive tension of the MTU was registered when submitted to static stretching for 30 seconds.

In the present study, a reduction of the passive tension of the hamstring muscles could have resulted in a greater maximum ROM after the stretching session. This explanation can be justified by different reasons. Considering that the flexibility assessment was performed in an active way, it is possible that changes of the maximal strength of knee extension muscles could influence the maximum ROM. However, significant change of maximal strength performance is not an expected response during this experimental design. Additionally, it must be considered that during extreme knee extension, the knee extension muscles are no longer able to generate great tensions whereas the hamstring muscles present an increased passive resistance due to the exponential behavior of the tension-deformation curve of the MTU. Therefore, the best performance at the flexibility test after the stretching session can be attributed to a reduction of the passive tension and not to increase of strength during the active test.

Another mechanism related to the acute change of maximum ROM is the increase of individual stretch tolerance (Magnusson et al., 1998). However, this reason should only be considered for the passive flexibility tests (Fantini et al., 2006). Therefore, it is likely that the increase of ROM verified in this study is a consequence of the changes of viscoelastic properties of the MTU.

The positive effect of stretching program on maximum ROM did not result in changes of knee extension ROM. Apparently the passive static stretching stimuli did not affect the knee extension ROM during a dynamic movement as Taekwondo kick ("Ap Tchagui").

CONCLUSION

A single session of passive static stretching, composed by four sets of twenty seconds, was sufficient to cause an increase in joint ROM, however in the present study this did not result in significant increase in the knee extension ROM during Taekwondo kick ("Ap Tchagui").

REFERENCES

- Fantini, C.H., Araújo, S., Menzel, H.J. & Chagas, M.H. (2006). Acute effect of quadriceps stretching on vertical ground reaction force, muscle activity and vertical jump performance. *In: XXIV International Symposium on Biomechanics in Sports*, Salzburg: University Salzburg, 675-678.
- Kim, Y.J. (1998). *Taekwondo Competition, the champion manual*. São Paulo: Brazil Sports Press.
- Magnusson, S.P., Aagaard, P., Simonsen, E.B. & Bojsen-Moller, F. (1998). A biomechanical evaluation of cyclic and static stretch in human skeletal muscle. *International Journal of Sports Medicine*, 19, 310-316.
- Netto, C.M, Moreira Júnior, L.A. & Chagas, M.H. (2003). Reliability of a modified active knee extension test. *In: XI Brazilian Biomechanics Congress*, Ouro Preto: Federal University of Minas Gerais - Brazil, 2, 149-152.
- Shrier, I. (2004) Does stretching improve performance? – A systematical and critical review of the literature. *Clinical Journal of Sports and Medicine*, 14, 267-273.
- Taylor, D.C., Dalton, J.D., Seaber, A.V. & Garret, N.E. (1990). Viscoelastic proprieties of muscle-tendon units. *The American Journal of Sports Medicine*, 18 (3), 300-309.