



RESEARCH ARTICLE

EFFECTS OF AN INTERMITTENT STATIC STRETCHING PROTOCOL: FLEXIBILITY GAINS AND MAINTENANCE OVER TIME

^{1,2}Massimiliano Gollin, ^{2,3}Luca Beratto and ^{*2,3}Federico Abate Daga

¹Department of Clinical and Biological Sciences; University School of Motor & Sport Sciences, University of Turin, Turin, Italy

²Adapted Training and Performance Unit - Research Group, University of Turin, Turin, Italy

³University School of Motor & Sport Sciences, University of Turin, Turin, Italy

ARTICLE INFO

Article History:

Received 22nd April, 2016

Received in revised form

05th May, 2016

Accepted 10th June, 2016

Published online 31st July, 2016

Key words:

Flexibility training,
Delayed effects,
Range of motion,
Maintenance of gains.

ABSTRACT

Objectives: To determinate the duration of the effects caused by Intermittent Static Stretching (ISS) on muscle elongation.

Background: Flexibility training is considered an essential physical quality in sport competition, injuries prevention and adapted physically activity. However, there is little information about the duration of the effects provoked by a stretching protocol on muscles-tendon unit, even if elongation exercises are very common in all physical activities. Methods: Eighteen fitness active participants aged 20-30 years were recruited for this study and casually assigned to an Experimental Group (EG) or a Control Group (CG). Participants were tested using the sit and reach test. EG used the sit and reach protocol also as experimental exercise. Test were taken for both groups at 3, 6, 9, 12, 15, 30, 45, 60, 120 minutes, after 4, 24, 48, 72 hours and the end 7 days after the last stretching set (EG) or basal condition measurement (CG).

Results: Friedman and Dunn's Post Hoc tests were used for statistical analysis. Results showed in EG increasing in basal R.O.M. ($p < 0,001$, +21%). In addition, this result is maintained for 48 hours. In the same group statistically significant decrease of gained ROM was identified at 72 hours ($p < 0,001$, -8%) and 7 days ($p < 0,001$, 10%) after the last ISS set. Instead, no significant differences were found in CG. Conclusion: The results of this study showed the duration of ISS stretching effects, giving the possibility to plan weekly the flexibility training during a microcycle.

Copyright©2016, Massimiliano Gollin et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Massimiliano Gollin, Luca Beratto and Federico Abate Daga, 2016. "Effects of an intermittent static stretching protocol: Flexibility gains and maintenance over time", *International Journal of Current Research*, 8, (07), 35225-35228.

INTRODUCTION

Flexibility training is considered an essential physical quality in sport competition, injuries prevention and adapted physically activity. (Alter, 2004; Anderson and Burke, 1991; Hubley *et al.*, 1984; Hubley and Kozey, 1984) Clinicians shows as a suitable hamstring and lumbar muscles flexibility can be an efficient way to prevent and decrease the low back pain pathology caused by hypo-kinetic syndrome (Esola *et al.*, 1996). On the other hand sport scientists (Witvrouw *et al.*, 2003) underline the strong correlation between weak hamstring flexibility and high frequency muscles strain. Despite this evidence, scientific literature do not provide precise information regarding the weekly periodization of a stretching routine and its effects on human muscles (Barnett, 1971; Biesterfeldt, 1974). Previous researches who investigated the duration of hamstring gains after cessation of an acute stretching protocol showed different results. Some authors sustained that hamstring flexibility gains obtained with static

stretching do not maintains for more than 6 minutes after the end of stretching exercise (DePino *et al.*, 2000; Ford and McChesney, 2007). Other authors affirmed that the effect of a stretching protocol can be identify 90 minutes after that a PNF protocol was stopped (Möller *et al.*, 1985). Finally, Voelker *et al.* (2007) asserted a maintenance of hamstring gains provoked by a passive-static stretching exercise until 24 hours after the end of their stretching protocol. All these works used different stretching techniques and some of them (Möller *et al.*, 1985; Voelker *et al.*, 2007; Madding *et al.*, 1987; Spornoga *et al.*, 2001; Cleary *et al.*, 2002; Hubley *et al.*, 1984; Henricson *et al.*, 1984) stopped post test measures before that subject muscles returned to basal conditions.

For this reason, it is not possible to identify an objective regression moment of stretching effect and, consequently, to communicate guarantee data about flexibility gains duration. Considering that, the aim of this study was to investigate the duration of the effects provoked by Intermittent Static Stretching (ISS) (Gollin *et al.*, 2011) on hamstring muscles over the course of 7 days.

*Corresponding author: Federico Abate Daga,
Motor Sciences Research Center, Adapted Training and Performance Unit,
Italy.

MATERIALS AND METHODS

Subjects

Eighteen amateur athletes (16 male and 2 female) aged 20-30 years with training routine of 3 times per week in fitness activities were recruited for this study. All participants did not suffer or feel pain at hamstring muscles during the testing period and signed an informed consent according to the Helsinki declaration.

Experimental procedures

Participants were randomly assigned to 2 groups: the experimental group (EG) and the control group (CG). EG was formed by nine people (8 male and 1 female age 24 ± 2 years, weight 70 ± 9 kg, high 174 ± 9 cm) and CG was composed by nine people (8 male and 1 female age 23 ± 2 years, weight 68 ± 11 kg, high 171 ± 11 cm). During the test sessions, participants were not allowed to modify their training schedules or their diet, and it was not permitted to perform any type of stretching program in order to avoid the risk of invalidating data. Both experimental and control group were tested using the Sit and Reach Test at the same time intervals. Post test measures were established at 3,6,9,12,15,30,45, 60,90,120 minutes, 4,24,48,72 hours and 7 days after the end of the stretching session or basal measure. All the protocol was conducted without a warm-up, to avoid uncontrolled alteration in the homeostasis of the soma. To avoid a learning effect, all participants were instructed to perform sit and reach test. Flexibility data were recorded from Monday to Saturday starting between 11:00 and 13:00 and ending between 15:00 and 17:00 to avoid physiological influences generated by circadian rhythms (Manfredini *et al.*, 1998).

Stretching Protocol

The stretching protocol consisted in performing 12 sets of maximal hamstring elongation, keeping position for 2 ± 1 seconds and resting 30 second between sets. Control Group performed just a basal measure without accomplishing all the stretching protocol. Both experimental and control group were tested at the same time intervals.

Instruments

A mixed metallic-wooden box (30 cm high, 50 cm wide and 51 cm deep) was used to measure trunk flexibility. This box included an 80 cm metallic rail running on its superior side, precisely in the central part. A little hand-cart with a laser distance meter Bosch (Germany) GLM 150 Professional (typical accuracy ± 1 mm, typical measuring time $< 0,5$ s, max 4 s, laser class 2, measure m/cm/mm, weight 0,24 kg, length 120 mm, width 66 mm, height 37 mm) roll over it. A metallic plaque is positioned at the end of the rail, to standardize measures. On the frontal side, a foothold is situated at 30 cm from the beginning of the rail. The foothold is composed by a wooden facade. A wooden triangle with the vertex facing downwards standing out from the facade central part. This triangle and the base of 17 cm makes an angle of 36° , named angle of Piok. The triangle sides create with the bases an angle

of 36° (Piok's angle) used to standardize feet placing point. (Figure 1).



Figure 1. The new version of Sit and Reach Parallelepipedon with digital distance meter

Participant Positioning

The participants were seated on the ground with legs extended and feet touching the sit and reach box. An operator controlled each positioning before starting trials to avoid compensations from feet and hips. In test starting position, the hands are joined and superimposed over the head with elbows extended in body midline. The hand positioned on the rod has to be the same in all other test sessions. Subjects flexed slowly the torso forward to the maximum elongation achieved without pain. Independently from the digital distance meter sit and reach test is repeatable, (Jackson and Langoford, 1989) so it was possible to use it for this study.

Statistical analysis

“P” level was established at 0,05 and data were analyzed with non parametric statistic. Friedman’s ANOVA and Dunn’s Post Hoc tests were used for statistical analysis. Percentage difference was calculated with the following formula: $\text{Diff}\% = ((\text{VAL fin.} - \text{VAL in.})/\text{VAL In.}) * 100$, where VAL In. = initial value and Val fin.= final values.

RESULTS

Friedman’s ANOVA showed a significant variation in muscles elongation during all test period (7 days) ($p < 0,001$). Dunn’s Post Hoc identified in EG a significant variation ($p < 0,001$, +21%, Figure 2) between basal conditions and the peak of R.O.M. reached after the stretching protocol. In addition, Dunn’s Post hoc underlined significant variation between basal conditions and 6 minutes after the end of stretching exercise ($p < 0,05$, +18%, Figure 1), 9 minutes ($p < 0,01$, +19%, Figure 2), 12 minutes ($p < 0,001$, +19%, Figure 2), 15 minutes ($p < 0,001$, +20%, Figure 2), 30 minutes ($p < 0,05$, +18%, Figure 1), 45 minutes ($p < 0,01$, + 19%, Figure 2). Significant regressive variations, were verified at 72 hours ($p < 0,001$, -8%, Figure 2) and 7 days ($p < 0,001$, -10%, Figure 2) after the end of stretching exercise.

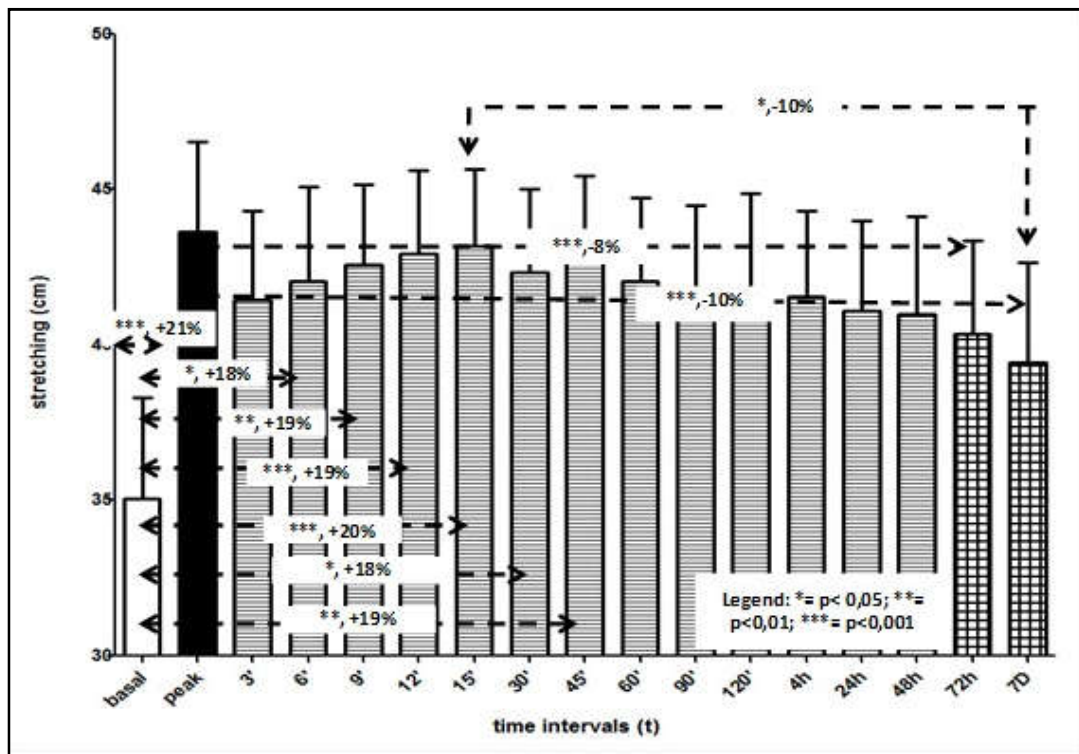


Figure 2. Delayed effects of intermittent static stretching. Significance was found between basal and peak measure ($p < 0,001$ +21%), basal conditions and 6 minutes ($p < 0,05$ +18%), 9 minutes ($p < 0,01$ +19%), 12 minutes ($p < 0,001$ +19%, Figure 1), 15 minutes ($p < 0,001$ +20%, Figure 2), 30 minutes ($p < 0,05$ +18%), 45 minutes ($p < 0,01$ +19%). Significant regressive variations, were verified at 72 hours ($p < 0,001$ -8%) and 7 days ($p < 0,001$ -10%) after the end of stretching exercise. Finally, Post Hoc identified a variation between 15 minutes and 7 days after stretching exercise ($p < 0,05$ -10%)

Finally, Post Hoc identified a variation between 15 minutes and 7 days after stretching exercise ($p < 0,05$, -10%). In CG Friedman's ANOVA did not show any significance difference among recorded measures.

DISCUSSION

Data show that the Intermittent Static Stretching (ISS) technique produce great benefits on hamstring muscle flexibility, increasing R.O.M till to 21% more than basal conditions ($p < 0,001$). In addition, this R.O.M. gain is conserved without significant variation from 6 to 45 minutes after the end of the stretching exercise. Non significant variation found 3 minutes after the end of the stretching exercise can be justified with what Willardson and Burkett (2008) and Rahimi *et al.* (2007) affirm about improvement in strength volume and peak. They sustain that strength peak and volume is obtained with a rest pause time between 21⁹ and 5²² minutes. Consequently, considering that during Intermittent Static Stretching muscle-tendon units were leaded at maximum discomfort point, is not still possible to observe the effect provoked by this technique 3 minutes after the end of ISS because the involved muscle-tendon units are still assimilating the stress received. Instead, CG did not show any statistically difference for every investigated time intervals. No significant variation was found in EG 45 minutes from the end of ISS exercise. However, 72 hours after the last repetition of stretching exercise a significant regression of maximum peak level was identified with a decrease of 8% of Maximum R.O.M. reached with ISS ($p < 0,001$, -8%). The same behavior

appeared 7 days after the end of the protocol with a decrease of 10% of Maximum R.O.M. reached with ISS ($p < 0,001$, -10%). The non significant variation found between 45 minutes and 72 hours can be lead to the fact that subject were re-tested every 24 hours after the first test day, so, this daily repetition caused by test procedures may influenced participants in a randomized and unverifiable way that did not allow to find a significant variation. However 72 hour later all the participants return to have an unvarying behavior.

Conclusion

A stretching schedule with Intermittent Static Stretching (ISS) produces great benefits on hamstring muscle flexibility, increasing R.O.M till to 21% more than basal conditions ($p < 0,001$) These gains are maintained for 48 hours after the end of the stretching exercise. This information can be very useful for trainers or people who operate in sport and rehabilitation because it gives the possibility to periodize stretching and flexibility training. For this reason agonistic sport sector, prevention and recovery and quality of life can be helped from this work.

REFERENCES

- Alter MJ 2004. Science of flexibility. (third edition). Champaign, IL, USA. Human Kinetics, chap 1.
- Anderson B, Burke ER 1991. Scientific, medical and practical aspects of stretching. *Clinical Sports Medicine*, 10:63-86

- Barnett CH 1971. The Mobility of synovial joints. *Rheumatology and Physical Medicine*, 11:20-27
- Biesterfeldt HJ 1974. Flexibility program. *International Gymnast*, 16(3): 22-33
- Cleary M A, Kimura I F, Sitler M L, Kendrick Z V 2002. Temporal Pattern of the Repeated Bout Effect of Eccentric Exercise on Delayed-Onset Muscle Soreness. *Journal of Athletic Training*, Jan-Mar, 37(1): 32-36
- DePino GM., MEd, ATC; Webright WG, MEd, ATC, PT; Arnold BL, PhD, ATC 2000. Duration of Maintained Hamstring Flexibility After Cessation of an Acute Static Stretching Protocol. *Journal of Athletic Training*, 35(1): 56-59
- Esola MA†, McClure P W‡, Fitzgerald GK‡, Siegler S 1996. Analysis of Lumbar Spine and Hip Motion During Forward Bending in Participants With and Without a History of Low Back Pain. *Spine*, 21(1):71-8
- Ford P, McChesney J. 2007. Duration of maintained hamstring ROM following termination of three stretching protocols. *Journal of sport Rehabilitation*, 16, 1-10.
- Gollin M., Luciano A., Casale L 2011. Estendibilità muscolo tendinea e riscaldamento. *SDS*, 30(88):55-62
- Henricson AS, Fredriksson K, Persson I, Pereira R, Rostedt Y, Westlin NE 1984. The effect of heat and stretching on the range of hip motion. *Journal of Orthopaedic & Sports Physical Therapy*, 6(2):110-115
- Hubley CL, Kozey JW, Stanish WD 1984. The effects of static stretching exercises and stationary cycling on range of motion at the hip joint. *Journal of Orthopaedic & Sports Physical Therapy*, 6(2):104-109
- Hubley CL, Kozey JW, Stanish WD 1984. The effects of static stretching exercises and stationary cycling on range of motion at the hip joint. *Journal of Orthopaedic & Sports Physical Therapy*, 6(2):104-109
- Hubley CL; Kozey JW 198). Can stretching prevent athletic injuries? *Journal of Musculoskeletal Medicine*, 19: 25-32
- Jackson A.W. and Langoford N.J 1989. The criterion related validity of the sit and reach test: Replication and extension of previous findings. *Research Quarterly for Exercises and Sport*, 60: 984-987
- Madding SW, Wong JG, Hallum A, Medeiros J. 1987. Effect of duration of passive stretch on hip abduction range of motion. *J Orthop Sports Phys Ther.*, 8(8):409-416
- Manfredini R., Manfredini F., Fersini C., Conconi F 1998. Circadian rhythms, athletic performance, and jet lag, *Br. J. Sports Med.*, 32: 101-106.
- Möller M, Ekstrand J, Oberg B, Gillquist J 1985. Duration of stretching effect on range of motion in lower extremities. *Archives of Physical Medicine and Rehabilitation*, 66:171-173
- Rahimi R, Boroujerdi SS, Ghaeni S, Noori SR 2007. The effect of different rest intervals between sets on training volume in male athletes. *Physical Education and Sport*, 5(1): 37-46
- Spernoga SG; Uhl TL†; Arnold BL‡; Gansneder BL‡ 2001. Duration of Maintained Hamstring Flexibility After a One-Time, Modified Hold-Relax Stretching Protocol. *Journal of Athletic Training*, 36(1): 44-48
- Voelker C. de Weijer VC, Gorniak GC, Shamus E 2007. The effect of static stretch and warm-up exercise on hamstring length over the course of 24 hours. *Journal of Orthopaedic & Sports Physical Therapy*, 33(12): 727-733
- Willardson JM, Burklett LN. 2008. The effect of different rest intervals between sets on volume component and strength gains. *Journal of Strength and Conditioning Research*, 22(1):146-152
- Witvrouw E, Danneels L, Asselman P, D'Have T, Cambier D. 2003. Muscle Flexibility as a Risk Factor for Developing Muscle Injuries in Male Professional Soccer Players. *The American Journal of Sports Medicine*, 31(1): 41-46.
