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Original Article

Effect of the Global Active Stretching (SGA®) for restoring the normal values of thermal asymmetry

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Abstract:
Increasingly, new Brazilian Jiu-Jitsu competitors are taking part in various competitions at various levels throughout the year. Most of these competitors are at the blue belt level and have a higher incidence of shoulder and elbow injuries. Before this fact, it arises the need to develop injury prevention strategies that can be practical, efficient and easy to be inserted within the competitor's training routine. Based on the parameter that thermal asymmetries in contralateral regions may indicate inflammatory processes and the practice of stretching for 10 minutes may have anti-inflammatory effect, we sought to analyze the practice of Global Active Stretching (SGA®) in the aid of the maintenance and restitution of normal values of thermal asymmetry for jiu-jitsu athletes' upper limbs. We analyzed through thermography the following body regions: shoulder, arm, elbow and forearm, considering anterior and posterior views of each one and comparing the corresponding contralateral region. We performed the capture of thermal imaging (thermographs) on three consecutive days, so that we could obtain them at three moments (previous, 24h later and 48h later). We carried out a SGA® self-posture for 15 minutes the next day after the jiu-jitsu competition. The results indicate that it is more advantageous to practice the SGA® rather than only rest for 48 hours after the competition. It is concluded that the practice of SGA® self-posture can restore normal values of thermal asymmetry in the posterior region of the forearm, which is an interesting factor to accelerate the recovery process.
KeyWords: Global active stretching; injuries; asymmetry; Brazilian jiu-jitsu; thermography..

Introduction

Nowadays, the growing popularity of Brazilian Jiu-Jitsu around the world has stimulated both the creation of competitions and appearance of new athletes. Most jiu-jitsu competitors are in the blue belt level and are affected by a higher incidence of shoulder and elbow injuries (Kreiswirth et al., 2014; Scoggin et al., 2014). Therefore, developing strategies for injury prevention is necessary(Scoggin et al., 2014; Kreiswirth et al., 2014).

With the advances in technology, the use of infrared thermography (IRT) has increased within the injury prevention programs for sports. IRT is a tool that allows to view the heat radiated from the body surface and measure the skin temperature (T_{SK}) in a fast, non-invasive way and without physical contact (Vargas et al., 2009). Among its application possibilities, we highlight the early identification of body thermal dysfunctions that may be related to inflammatory processes resulting from physical exercise (Arnaiz-Lastras et al., 2014). Measuring T_{SK} after competition has been recently suggested as a useful strategy in management of training load, offering information about muscle recovery status (Fernandes et al., 2017).

Under normal conditions, the T_{SK} might be similar between contralateral regions of the body (Gatt et al., 2015). Thermal symmetry patterns have been reported in adults (Marins et al., 2014b) and young soccer players non-injured (Marins et al., 2014c). Conversely, thermal asymmetries have been associated with physiological and structural abnormalities in athletes (Hildebrant et al., 2010), which may be directly associated to the training overload, incomplete recovery and exercise-induced muscle damage (Fernández-Cuevas et al., 2014).

Marins et al., (2015) proposed a scale of attention level, according to the differences of T_{SK} obtained between contralateral body regions of interest (ROIs), considering: (a) Normal: asymmetries ≤ 0.4 °C; (b)

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Monitoring: asymmetries ≥ 0.5 °C (it is advisable to reassess and see if there is an influence of some external factor); c) Prevention: values between 0.8°C and 1.0°C (it is suggested a load reduction, or even training suspension, and medical or physiotherapeutic assessment); d) Alarm: values between 1.1°C and 1.5° C (immediate training suspension and medical or physiotherapeutic assessment); e) Gravity: asymmetries ≥ 1,6 °C (it suggests an asymmetry with pathological feature or an important injury, with recommendation of medical or physiotherapeutic evaluation).

Despite the advances in the prior identification of possible injuries, it is necessary to implant practical procedures in the athletes' training routine in order to prevent them. Among the procedures, there is the practice of stretching. However, the implantation of this type of training in the athletes' routine still causes disagreement over the years in the scientific community (Hebert, et al., 2013; ACSM, 2014; Lewis, 2014). Such discrepancies are also found when the subject is specifically directed to the practice of stretching in Brazilian Jiu-Jitsu. (Costa et al., 2009; Oliveira et al., 2014).

Nevertheless, studies show that the maintenance of stretching for 10 minutes has a direct effect on the regulatory mechanism of inflammation in the connective tissue (Berrueta et al., 2016). Such conclusion is something that differs completely from the maintenance time recommended for conventional stretching exercises. The conventional approach recommend a duration of 10 to 30 seconds approximately, which has already been used in studies involving Jiu-Jitsu (ACSM, 2014; Costa et al., 2009; Oliveira et al., 2014). In other words, there is a hypothesis that the performing of stretching with proper time and care, just as used in the study of Berrueta et al. (2016), may help in the maintenance and restoration of normal thermal asymmetry values.

Despite the advances in the prior identification of possible injuries, it is also necessary to implant practical procedures in the athletes training routine in order to prevent them. Stretching exercises are commonly proposed with this aim, although performing this type of training still has generated disagreement over the years in the scientific community (Hebert, et al., 2011); ACSM, 2014); Lewis, 2014). Such discrepancies are also found when the subject is specifically directed to the practice of stretching in Brazilian Jiu-Jitsu (Costa et al., 2009); Oliveira et al., 2014).

Nevertheless, a recent study has shown that the maintenance of stretching for 10 minutes has a direct positive effect on the regulatory mechanism of inflammation in the connective tissue (Berrueta et al., 2016). This time duration of exercise (10 min) differs completely from the maintenance time recommended for conventional stretching exercises. The conventional approach recommend a duration of 10 to 30 seconds approximately, which has already been used in studies involving Jiu-Jitsu (ACSM, 2014); Costa et al., 2009); Oliveira et al., 2014). In other words, there is a hypothesis that performing of stretching with proper time and care, just as used in the study of Berrueta et al. (2016), may be helpful to attenuate the exercise-induced inflammatory response and, consequently, improve recovery status after exertion. Global Active Stretching (SGA®) is a non-conventional stretching method that most closely approximates to the recommendation for stretching maintenance time suggested by Berrueta et al. (2016) (Grau, 2004); Souchard, 2012). With proper care in order to not damage the muscle tissue and with the active job in the connective tissue, the method is based on application of principles and foundations of the Global Postural Re-education for the sport, intending injury prevention, maintenance or improvement of physical performance (Souchard, 2012). Although SGA® has been proposed as a strategy to prevent injury and improve muscle recovery after exercise, few studies have tested its effectivity for these finalities (Almeida Jr et al., 2018). Thus, the aims of the current study were twofold: (1) to verify the effect of a jiu-jitsu simulated championship on T_{SK} measured by thermography and (2) to analyze the impact of SGA® practice on T_{SK} values and thermal asymmetry in jiu-jitsu practitioners.

Material & methods

Participants

The sample was composed by 18 male jiu-jitsu practitioners (25.0 ± 3.1 years, 77.3 ± 5.4 kg body mass, 175 ± 4 cm height, 9.9 ± 3.9% body fat), registered at the Jiu-Jitsu Federation of Sergipe, Brazil. The following inclusion criteria were considered: being competing at regional level; having at least 2 years of experience in the sport and having a minimum frequency at the trainings of five days a week. For exclusion: being injured; having skin burns on the upper limbs; fever within the past seven days; having physiotherapy sessions; using dermatological creams, ointments or lotions for local use; using antipyretics or diuretics drugs, or food supplement that can interfere with the water homeostasis or body temperature in the last two weeks.

Before providing their writing informed consent, all subjects were informed of the requirements and risks of the study. The study was approved by the Ethics Committee in Research with Human Beings of the Federal University of Sergipe (Positon paper nº. 1.586.126) and was conducted in accordance with the Declaration of Helsinki.

Procedures

This cross-sectional study was carried out in the Cineanthropometry Laboratory (data collection) and Fight Room (championship simulation) at the Federal University of Sergipe. Participants were randomly assigned to control (CG n=9) or experimental (EG) groups. The experimental protocols were performed in three

consecutive days: 1) immediately after obtaining baseline thermal images (thermograms), all participants underwent jiu-jitsu championship simulation; 2) thermographic protocol 24 h post-competition, just followed by the SGA intervention to EG and no exercise to CG; 3) thermographic protocol 48 h post-competition (24 h after SGA). Figure 1 presents the schematic representation of the research design.

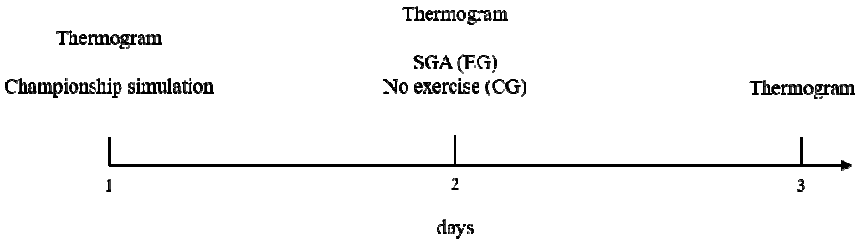

Figure 1. Schematic representation of the research design. EG: experimental group; CG: control group.

Thermographic Images

The thermographic protocol were performed according to recommendations of the European Association of Thermology (Ammer and Ring, 2006), in an artificially illuminated room with fluorescent lights, without air flow directed to the subjects, with environmental temperature (21.8 ± 0.7 °C) and relative humidity (RH) (48.5 ± 2.4%) controlled and monitored by a thermohygrometer (Highmed, HM-01) (Fernández-Cuevas et al., 2015). Thermograms were taken during three consecutive days in the following moments: immediately before jiu-jitsu championship simulation protocol (1st day); 24 h (2nd day) and 48 h (3rd day) after championship.

The competitors were instructed to not perform any vigorous physical activity within the last 48 h before the assessment, to not consume alcohol or caffeine, to not use any type of skin cream or lotions within the last 6 hours before the assessment. All thermographic assessments were performed approximately at 8:00 p.m., after a minimum period of 10 minutes to acclimatization. Subjects wore only swimming trunks, remained standing, did not perform any abrupt movement, did not cross their arms and or scratch themselves (Marins et al., 2014a). At the moment of acquisition thermograms, the participants were in anatomical position and the camera was stabilized on a tripod, 1.5 m distant from each individual, with the lens positioned perpendicularly to the ROIs. The T_{SK} of the body regions of interest (ROI) was obtained by a thermal imager C2 (Flir System, Stockholm, Sweden), with measurement ranging from -10°C to 150°C, accuracy of 2%, sensitivity < 0.10, infrared spectral band 7.5 - 14 µm, refresh rate of 9 Hz, resolution of 80 x 60 pixels, with emissivity set in 0.98 (Steketee, 1973). For the delimitation of ROIs, anatomic points were adopted in the anterior region of the shoulder, anterior region of the arm (the cubital fossa and axillary line), the anterior region of the elbow and anterior region of the forearm (the cubital fossa and the distal-third forearm), and their corresponding points in the posterior region (Marins et al., 2014a); Fernández-Cuevas et al., 2014). The values of ΔT_{SK} between the contralateral regions were measured. Figure 2 presents the thermogram of a participant with delimitation of the ROIs, performed in software Flir Tools (Flir System, Stockholm, Sweden).

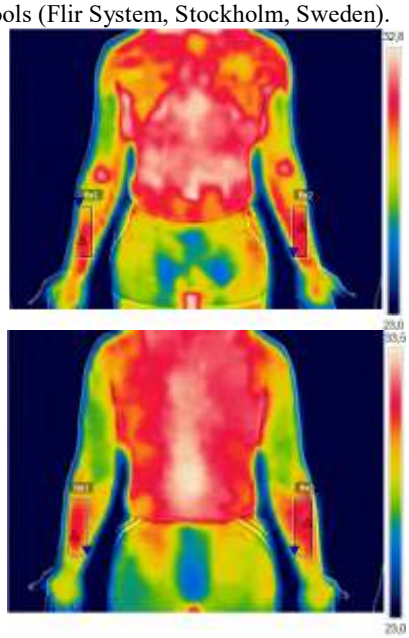

Figure 2.Thermograms of a participant with the ROI delimitation in anterior (a) and posterior views (b).

Competition simulation

In order to represent as close as possible the real situations in competition (Kreiswirth et al., 2014), the 18 competitors represented three jiu-jitsu teams in Aracaju city, each team with six representatives. After the fight draw, except if members of the same team were randomly selected for a fight, each athlete held three 6-minute fights, with 10-minute intervals between each fight, according to the championships' rules organized by the Jiu-Jitsu Federation. However, in order to ensure a homogeneous fight duration for all the competitors, when there was a "finalization" before the maximum time for each fight, the timer was paused until the fight began again. After the fight started again, the count of the stopwatch was resumed in order to complete the time determined by the study.

Global Active Stretching – SGA®

After the thermographic protocol of 2nd day, the CG performed no exercise, just rested. Meanwhile, the experimental group performed the self-posture "lying on back with arms open" for 15 minutes for the stretching of the scapular waist, arms and forearms (Figure 3) (Souchard, 2004).

In order to perform this self-posture, initially the individual was positioned in dorsal decubitus position, arms outstretched and distant at 45° from the body, supporting the most of the lumbar region on the floor, knees flexed and feet support on the floor (Grau, 2003). With deep exhalation of the upper part of the chest, gradually the individual was abducting one's own arms to reach the angle of 90°, where he placed the palm of his hand toward the ground, without compensation of the shoulder and/or elbow rotation. He performed an extension of wrist and fingers, executed three small eccentric contractions, lasting three seconds each against resistance imposed by the guide duly enabled. At the end of the last contraction, it was possible to insist on amplitude gaining through the inverse myotatic reflex (Grau, 2003; Souchard, 2012).

Figure 3."lying on back with arms open" self-posture

Statistical analysis

We performed descriptive statistics (mean and standard deviation), then applied the test of normality (Shapiro-Wilk) in order to verify the data distribution. We applied the Friedman test to monitor the T_{SK} values over time. When significant differences were found, we used the Wilcoxon post-hoc test to identify them, considering as significant p values ≤ 0,0167, according to Field, (2009). In order to compare the equivalent moments between groups, the Mann-Whitney test was applied.

All the tests were performed using the program SPSS for Windows v. 20.0 (IBM, EUA). The effect size was calculated and considered significant values $p \leq 0.05$ in the Friedman and Mann-Whitney tests.

Results

Table 1 presents the results of each group, with the average of ΔT_{SK} (°C) in the ROIs during the moments and the differences between the groups for the equivalent moments.

Table 2 shows the values of the *post hoc* Wilcoxon test for each significant value after the Friedman test.

Table 1.Averages of the ΔT_{SK} (°C) during the moments in the body regions of interest (ROIs).

		EG				CG			
ROI	**View**	**Pre**	**24h**	**48h**	***P***	**Pre**	**24h**	**48h**	***P***
Shoulder	A	0.54 ± 0.40	0.43 ± 0.28	0.38 ± 0.29	0.81	0.36 ± 0.25	0.31 ± 0.39	0.30 ± 0.25	0.27
	P	0.35 ± 0.24	0.54 ± 0.53	0.35 ± 0.28	0.48	0.24 ± 0.25	0.33 ± 0.35	0.30 ± 0.25	0.26
Arm	A	0.27 ± 0.36	0.53 ± 0.45	0.23** ± 0.21	0.23	0.30 ± 0.38	0.40 ± 0.46	0.60** ± 0.39	0.07
	P	0.21 ± 0.20	0.46** ± 0.33	0.27 ± 0.19	0.05*	0.31 ± 0.34	0.15** ± 0.18	0.31 ± 0.11	0.10
Elbow	A	0.41** ± 0.27	0.22 ± 0.16	0.37 ± 0.27	0.16	0.15** ± 0.16	0.22 ± 0.20	0.42 ± 0.35	0.07
	P	0.26 ± 0.29	0.45 ± 0.38	0.23** ± 0.26	0.40	0.27 ± 0.22	0.23 ± 0.11	0.57** ± 0.27	0.03*
Forearm	A	0.27 ± 0.20	0.36 ± 0.30	0.20 ± 0.20	0.49	0.17 ± 0.17	0.17 ± 0.04	0.24 ± 0.12	0.27
	P	0.35 ± 0.32	0.41** ± 0.26	0.23 ± 0.17	0.03*	0.18 ± 0.15	0.17** ± 0.13	0.27 ± 0.15	0.04*

Footnote: ROI = body region of interest EG = experimental group; CG= control group; A = anterior; P = posterior; ± = standard deviation (SD).
**statistically significant values for $p \leq 0.05$ of the Friedman test.*
***difference at the corresponding moment between the groups with statistically significant values for $p \leq 0.05$ of the Mann-Whitney test.*

Table 2.*Post hoc* of Wilcoxon test for significant values of the Friedman test.

ROI	GROUP	Pre-24h	Pre-48h	24h-48h	Effect size
Elbow P	Control	0.592	0.135	0.007*	0.63
Forearm P	Control	0.665	0.011*	0.077	0.28
Arm P	Experiment	0.614	0.757	0.489	-
Forearm P	Experiment	0.550	0.324	0.011*	0.37

Footnote: ROI = body region of interest; P = posterior.
**statistically significant values for $p \leq 0.0167$.*

The CG average values of ΔT_{SK} (°C) for the posterior elbow and forearm rejected the null hypothesis, when compared at 24h-48h and Pre-48h, respectively, whereas the EG rejected the null hypothesis on the posterior forearm mean value at the moment 24h-48h. There is a difference between groups at these moments: 48h of the anterior arm, 24h of the posterior arm, Pre of the anterior elbow, 48h of the posterior elbow, 24h of the posterior forearm.

Dicussion

The objective of this study was to verify the effect of a jiu-jitsu simulated championship on T_{SK} measured by thermography and to analyze the effect of SGA® practice on T_{SK} values and thermal asymmetry in jiu-jitsu practitioners. The results indicate an increase in the ΔT_{SK} (°C) of 0.34°C to the posterior elbow and 0.09°C for the CG posterior forearm. In the EG, there was a decrease in the ΔT_P (°C) of 0.18°C for the posterior forearm. All statistically significant changes had in common the comparison with the moment of 48 h.

A possible explanation for the increase of the ΔT_{SK} (°C) after 48h in the CG can be associated with the thermal response after a high-intensity exercise as proposed with the competition simulation, by the inflammatory process for muscle recovery, where the increase of T_{SK} tends to be greater after 48h, 72h and 96h (Neves et al., 2016) which, in this case, might have contributed to the increase of ΔT_{SK} (°C) (Marins et al., 2015) due to the specificity of the modality or the competitor's dominant arm.

In Marins et al., (2014b) and Zhu and Xin's, (1999) studies, the results show $\Delta T_{SK} \leq 0.3$°C as a normal average for the contralateral regions in healthy individuals. For sports, Marins et al., (2015) concluded that the ΔT_{SK} normal reference is ≤0.4°C, except for some cases of specificity, as a judo practitioner who occasionally may present an asymmetry from 0.4°C to 0.8°C in the forearm and be considered normal due to the effort in achieving the *"kumi kata"*.

In spite of the exceptions, the authors are unanimous in believing that the $\Delta T_{SK} \geq 1$°C in the contralateral regions is a significant problem (Uematsu, 1985); Marins et al., 2015). For this reason, it is necessary to create an athlete thermal profile, in order to know what can be considered normal for the individual,

preventing them from presenting and/or keeping high values of asymmetry which, regardless of the specificity, are considered harmful. Contrary to the expectations of the thermal response after high-intensity exercise that has influence of specificity, the EG presented a decrease of ΔT_{SK} (°C) at the moment of 48h. SGA® self-posture is one factor that might have interfered with that response, which supports the hypothesis that the stretching has anti-inflammatory effect (Berrueta et al., 2016).

According to Berrueta et al., (2016), the explanation for the stretching anti-inflammatory effect is in its ability to increase the pro-resolution mediators by cells residing in the connective tissue (fibroblasts and/or monocytes), with direct mechanical effect in the regulation molecules of inflammation within the connective tissue. In other words, inhibiting the neutrophil migration through the connective tissue lengthening, regardless of other systems such as the vascular, lymphatic or neuromuscular.

Such importance is given to the connective tissue lengthening due to its role of being a place for immunological changes throughout the body, as well as the way in which the water, proteins and immune cells return to the blood through the lymph vessels (Langevin et al., 2013).This tissue operates both in the acute inflammation resolution, as in the transition from acute inflammation into chronic inflammation (Naylor et al., 2013); Berrueta et al., 2016). However, the major focus of SGA® self-posture is precisely the lengthening of connective tissue, aiming at plasticity, more lasting effects, based on principles and foundations of the method, such as the "creep" physical phenomenon and the active job with the maintenance of a superior time, when compared with conventional methods (Souchard, 2004); Souchard, 2012).The aforementioned fact differentiates the method used in the present study from others already investigated and described as ineffective or harmful (Costa et al., 2009); Herbert et al., 2011).

Another finding of this study is related to the levels of attention to asymmetry proposed by Marins et al., (2015). It is observed that there are differences between the groups at the moments 48h of the anterior arm and 48h of the posterior elbow with their respective values of (EG = 0.23 °C; CG = 0.60 °C) and (EG = 0.27 °C; CG = 0.57 °C). In this sense, the experimental group is in normal stage for the level of asymmetry attention, with values ≤ 0.4°C, whereas the control group is at the monitoring stage, with values ≥ 0.5°C. Due to this fact, according to Marins et al., (2015), it is recommended for the control group a reevaluation to analyze if there is interference of some external factor which, in this case, it is probably associated to the thermal response of 48h after exercise. The EG has as a factor having performed SGA® one day prior to the 48h-moment assessment, something that can justify a reduction of the thermal asymmetry, collaborating for the competitor to stay in normal phase at the levels of asymmetry attention.

Other differences between groups were also found at the moments: 24h of the posterior arm, Pre of the anterior elbow and 24h of the posterior forearm. These differences may be associated with the competitor's thermal profile before the competition and/or the response itself of 24h after the competition (Fernandez et al., 2015). The results corroborate that the elbow region (Scoggin et al., 2014); Kreiswirth et al., 2014) and, consequently, nearby regions such as forearm and arm are more prone to injuries in jiu-jitsu competitors. However, we suggest that further studies with a larger sample size might better clarify the findings of the present study, even inducing to an inflammation in specific regions so that the real effect of SGA® self-posture practice can be proved before a possible inflammation in these regions.

In short, in case the jiu-jitsu practitioner wishes to speed up the recovery process to the forearm region after the competition, performing a SGA® self-posture for 15 minutes on the following day after the competition might be more advantageous rather than just rest for 48h after the competition.

Conclusions

The SGA® practice self-posture, besides not harming the maintenance of thermal asymmetry normal values in jiu-jitsu practitioners' upper limbs contralateral regions, can restore normal values of thermal asymmetry in the forearm posterior region.

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Conflicts of interest

The authors declared NO conflict of interests regarding the publication of this manuscript.

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