

Effect of sport massage on pressure pain threshold and tolerance in athletes under eccentric exercise

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Abstract

Extensive line of evidence suggest that pain threshold and tolerance alters following exercise, although the mechanisms have not been elucidated yet. In this study, we investigated the role of sport massage on pressure pain threshold and tolerance in athletes under eccentric exercise. Ten male athletes aged 23 ± 1 years with 9.67 ± 3.04 years of athletic training were recruited for this study. Following baseline measurements of pressure pain threshold and tolerance from m. biceps brachii and m. triceps brachii muscle and myofascial regions of the dominant upper extremity by using a digital algometer, subjects were underwent an acute bout of eccentric exercise. Participants were completed 4 sets of eccentric exercise each comprising 20 repetitions of lifting 80% of their 1 RM by using a dumbbell. Pressure pain threshold and tolerance tests were repeated 10, 20 and 30 minutes, and 24 and 48 hours following exercise. One week after eccentric exercise, sport massage protocol for 10 minutes was manually administered to the dominant arm immediately after exercise, and all measurements were repeated at the same timeline as eccentric exercise. Results are presented as mean + standart deviation. Data of the same timeline were analyzed by using t test. A level of $p < 0.05$ was accepted statistical significant. Eccentric exercise resulted to increase the pain tolerance from muscle and myofascia regions of m. biceps and triceps brachii, and sport massage was found to decrease the pain tolerance at 10 minutes from muscle regions of m. biceps and triceps brachii, 10, 20 and 30 minutes from myofascial region of biceps brachii, and 20 minutes, 24 and 48 hours from myofascial region of m. triceps brachii following acute bout of eccentric exercise in athletes. We concluded that sport massage reduces the hypoalgesic response during acute and delayed period of recovery after eccentric exercise.

Key Words: eccentric exercise, exercise-induced hypoalgesia, sport massage, pain tolerance

Introduction

It has been well-established that eccentric exercise causes symptoms of muscle damage such as pain, tenderness and strength loss. The symptoms seem to notice at 24 hours following exercise, and subside after 5-7 days. The name DOMS (delayed onset muscle soreness) is used to describe this phenomenon (Clarkson and Sayers 1999; Clarkson and Tremblay 1988).

A number of functional, structural and biochemical changes occur in association with DOMS after eccentric exercise. These include declines in muscular strength and power (Sargeant & Dolan, 1987), decreased flexibility and range of motion (Saxton et al., 1995), myofibrillar Z-band and sarcomere length disruption (Friden and Lieber, 1992), swelling, and efflux of intramuscular proteins into the blood stream (Franklin, Currier & Franklin, 1991). While the mechanism(s) responsible for DOMS are not clear, the sensitisation of free nerve endings in response to inflammation and efflux of substances from muscle fibres into the extracellular space have been indicated as possible contributing factors (Stauber et al., 1990). Pharmacological agents have been used to reduce DOMS with limited success (Mishra et al., 1995). Various physical therapies such as stretching and warm-up (High, Howley and Franks, 1989), transcutaneous electrical stimulation (Denegar et al., 1989), athletic massage (Smith et al., 1994) and ice massage (Isabell et al., 1992) have also been utilised to ameliorate DOMS. Massage is widely used as a therapeutic modality for recovery from muscle fatigue and injury (Tiidus 1997 and 1998, Ernst 1998, Robertson et al. 2004 and is probably one of the most popular treatments after sports activities. Although physiological theory to support how massage facilitates recovery from eccentric-exercise-induced muscle damage is obscure, a massage is often recommended by coaches and therapists to alleviate or prevent DOMS after a sporting activity (Tiidus 1997).

Pain perception in athletes is commonly believed to differ from pain perception in sedentary persons (Tesarz et al. 2012). It has been established that athletes frequently continue to exercise in the face of severe injury. Several reports demonstrated that long-standing physical activity may alter pain perception and have often concluded that athletes possess higher pain thresholds and higher pain tolerance (Cook and Koltyn 2000).

The aim of this study is to investigate the effect of sport massage on pressure pain threshold and tolerance following single bout of eccentric exercise. We repeated our measurements at rest, 24 and 48 hours of recovery period following exercise.

Methods

Participants

The study was conducted at Sport Science and Application Center of Akdeniz University. Ten male athletes were participated into this study.

Eccentric exercise protocol

The participants were completed 4 sets of eccentric exercise, each comprising 20 repetitions of lifting 80% of their 1RM. The exercise protocol was applied to the dominant upper extremity by using a dumbbell in the chair. Shoulders of the players were supported and their elbows were positioned to 90° flexion. The players were asked to drop the dumbbell on the

ground as such each repetition would end in 2 to 3 seconds. For the next repetition the dumbbell was brought to the starting position by the researcher (Serinken et al. 2013).

Sport massage protocol

A standard 10-minute sports massage was applied to the exercised arm by a qualified massage therapist 5 minutes following eccentric exercise. The therapist was a professional masseur who had been working on massage for several years. The 3-days time point was chosen based on a previous study (Smith et al. 1994). The massage protocol used deeply applied clearing techniques with palmar and finger stroking to the muscles. Massage was applied as the subject sit on a chair. The 10-minute massage consisted of effleurage (stroking) of the hand (30 seconds), wrist to elbow (1 minute), and elbow to shoulder (1 minute); petrissage (kneading) of the wrist to the elbow (30 seconds) and elbow to shoulder (30 seconds); frictions to the forearm (1 minute), biceps, triceps, and deltoids (1 minute); thumb petrissage of the wrist to the elbow (1 minute) and elbow to shoulder (1 minute); and repeat effleurage of the hand (30 seconds), wrist to elbow (1 minute), and elbow to shoulder (1 minute). Under verbal instruction, the same therapist performed the massage protocol throughout the experiment. The therapist was requested to keep the depth and rate of massage as consistent as possible (Zainuddin et al. 2005).

Assessment

Height was measured using an ultrasonic height measure (Soehnle-Waagen GmbH & Co. KG). Body weight, % fat, fat mass, free fat mass (FFM) and total body water (TBW) was measured with a Tanita Body Composition Analyzer (Model TBF-300 TANITA, Tokyo, Japan). Skinfold of dominant arm was measured by using calliper.

Pressure pain threshold (PPT) and pressure pain tolerance (PPTO) measurement

Pressure pain threshold and tolerance were measured via an algometer (FPIX 50, Wagner Instruments, Greenwich, CT). PPT and PPTO values of participants were obtained from muscle and myofascial region of dominant arm. Single measures of both threshold and tolerance were taken at 90-second intervals to prevent habituation (DeWall and Baumeister 2006, Orbach et al. 1997). PPT and PPTO measurements were repeated at rest, and during 10, 20, 30 min, 24 and 48 hr of recovery period following eccentric exercise and/or sport massage.

Statistical analysis

Results are presented as means + SD. Statistical significance was assessed by repeated measures of ANOVA followed by Tukey's post hoc test. A level of $p < 0.05$ was accepted statistically significant.

Results

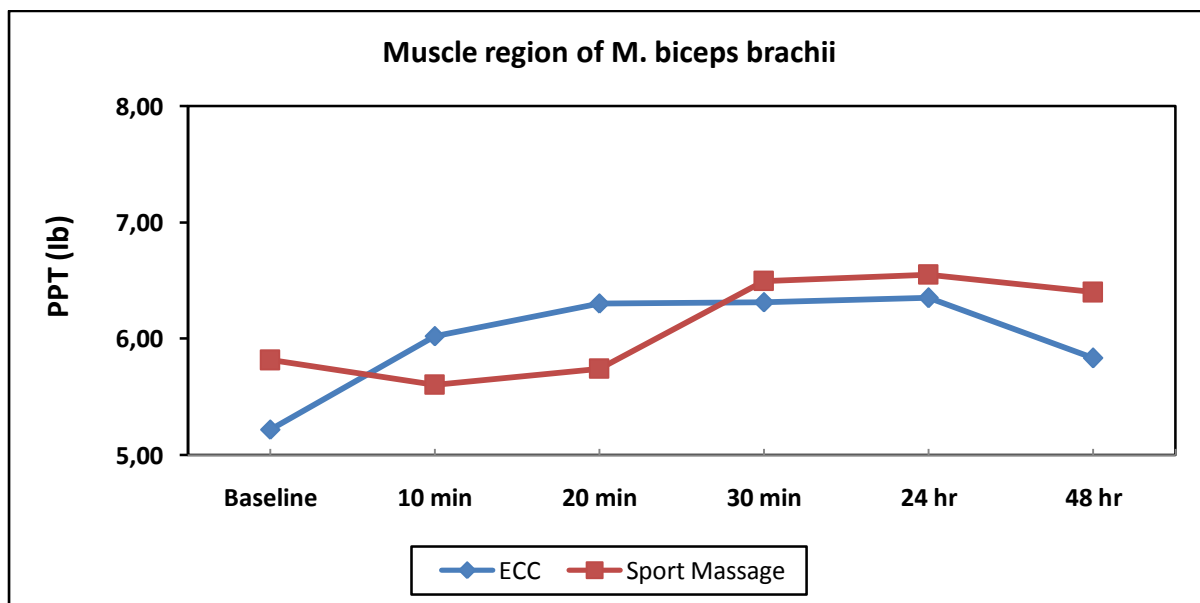
Table 1 summarizes the demographic characteristics and body composition of the participants. The participants were young, had higher athletic training status and low fat mass according to the reference values of the general normative data (Pi-Sunyer 2000).

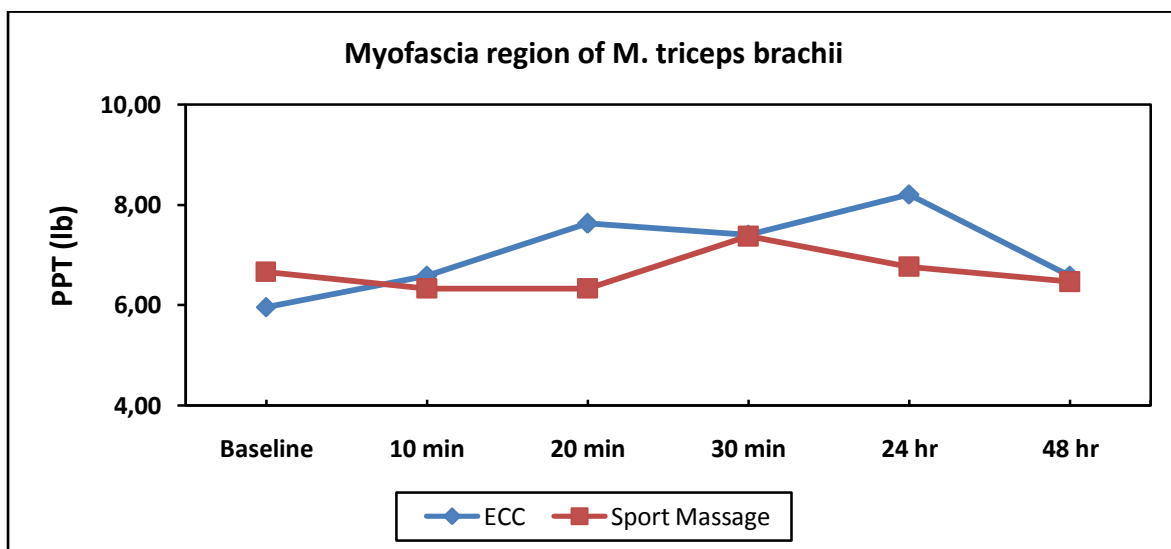
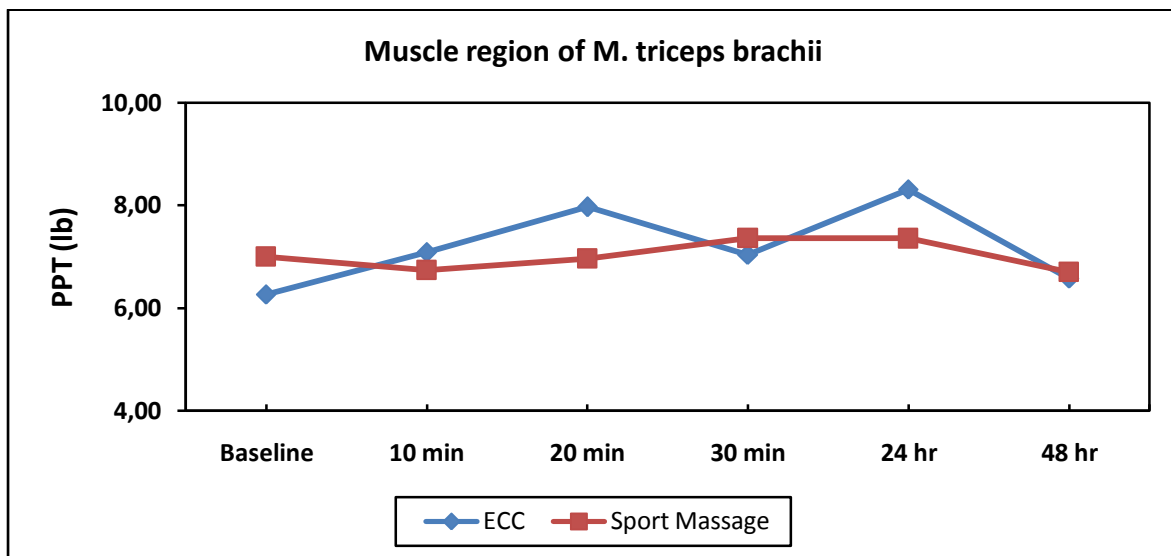
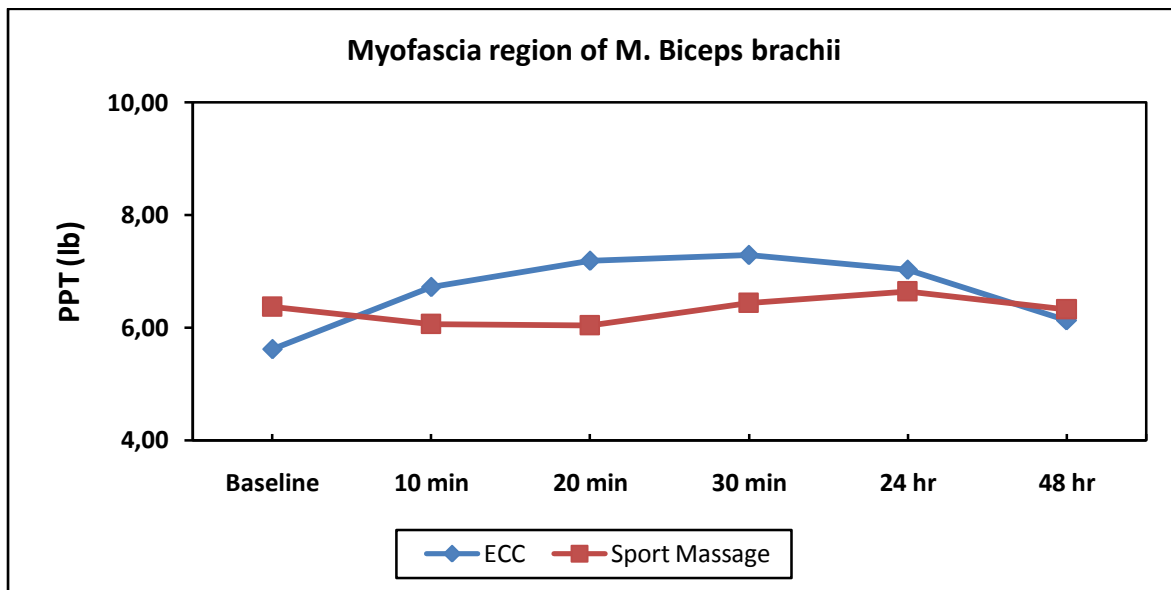
Table 1. Demographic characteristics of the participants

Age (years)	23 ± 1,00
Height (cm)	178,00 ± 7,28
Body weight (kg)	74,34 ± 7,72
BMI	23,46 ± 2,00
Athletic training status (years)	9,67 ± 3,04
% Fat	9,00 ± 3.96

PPT and PPTO results obtained from four region of dominant arm of two groups are presented in Figure 1 and 2. Although we did not found significant differences between ECC (eccentric exercise) and sport massage on pain threshold as presented in Figure 1, eccentric exercise resulted to increase the pain tolerance from all regions of dominant upper arm at all time periods compared with the baseline and sport massage values ($p < 0.05$). On the other hand, sport massage was found to decrease the pain tolerance at 10 minutes from muscle regions of m. biceps and triceps brachii, 10, 20 and 30 minutes from m. myofascial region of biceps brachii, and 20 minutes, 24 and 48 hours from myofascial region of m. triceps brachii following acute bout of eccentric exercise in athletes (Figure 2).

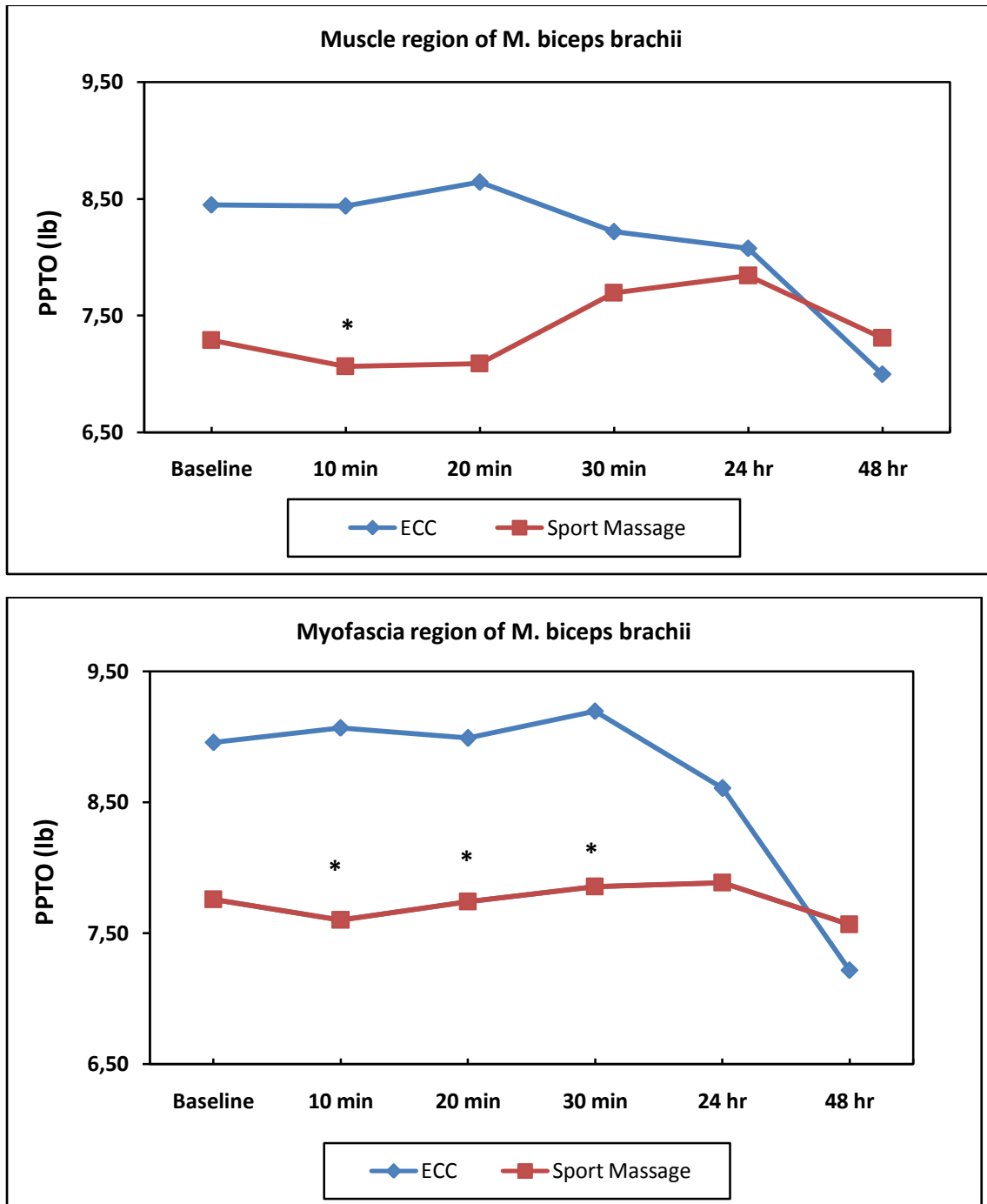
Figure 1. Average PPT (pressure pain threshold) of muscle and myofascial regions of M. biceps and triceps brachii during rest, and following eccentric exercise or sport massage (lb)

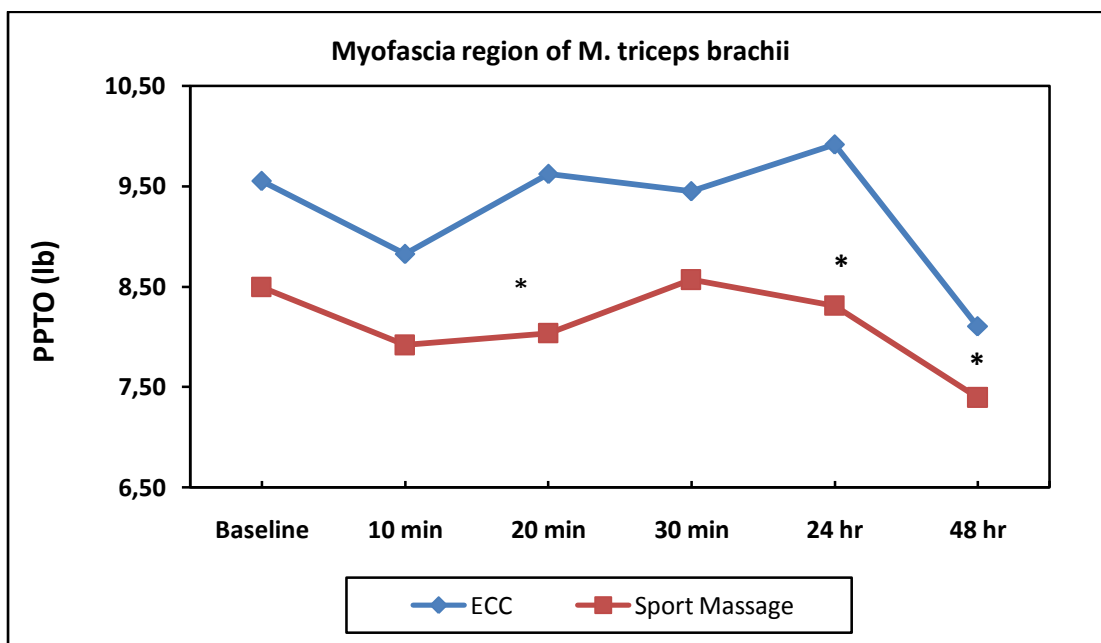
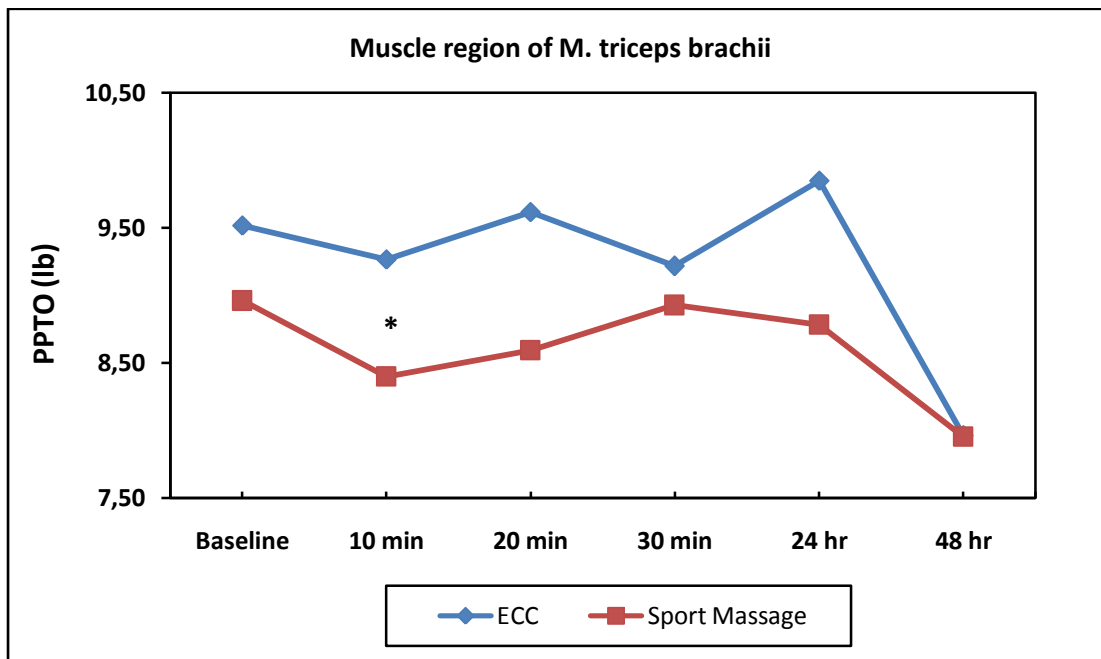




Values are expressed as mean + SD, n = 10 for each measurement. ECC: Eccentric exercise

Figure 2 Average PPTO (pressure pain tolerance) of muscle and myofascial regions of M. biceps and triceps brachii during rest, and following eccentric exercise or sport massage (lb)





Values are expressed as mean + SD, n = 10 for each measurement. ECC: Eccentric exercise, *p<0.05, difference from corresponding ECC measurement.

Discussion

This study evaluated the effect of sport massage on pain threshold and tolerance after single bout of eccentric exercise in athletes. The results of the present study demonstrated that sport massage may have an impact on pain tolerance in post-exercise period. To our knowledge,

this is the first study evaluating the effect of sport massage on pain tolerance alterations after acute eccentric exercise in athletes.

Demographic characteristics of the participants in the present study showed that the participants have low body fat and high athletic training years with $9,67 \pm 3,04$ years (Table 1). As a result, our participants are accepted as athletes. All athletes were played football throughout the athletic training lifetime.

In the present study, we did not find significant differences on pain threshold after eccentric exercise, or sport massage. However, our results clearly demonstrated that single, acute eccentric exercise induced a hypoalgesic response throughout the 48 hr of recovery period following exercise (Fig 2). Our results are in accordance by the previous reports showing exercise-induced hypoalgesic response (Koltyn 2000, Ozkaya 2014). Several factors are suggested to play a role in exercise-induced hypoalgesia, including increased inflammatory response after exercise may release a variety of inflammatory mediators including reactive oxygen species (ROS), prostaglandin E₂, leukotrienes, bradykinin, substance P, thromboxanes, inflammatory cytokines such as tumor necrosis factor (TNF)- α or interleukin (IL)-6, nerve growth factor, ATP and adenosine (Ambriz-Tututi et al. 2000, Kilic et al. 2014). Some of these agents are known to activate nociceptors, while others release local algogenic agents. Algogenic substances may contribute to pain transmission pathways and causing primary hyperalgesia. We have also previously shown that exercise increases plasma melatonin concentration which has been known an analgesic substance in exercise trained animals (Ozkaya et al. 2014, Ozdemir et al. 2013), and endogenous melatonin is one of the candidate which may contribute the hypoalgesic response following exercise.

In the present study, sport massage seems to be effective to restore the hypoalgesic response at 10 min in muscle region, and at 10, 20, 30 min following exercise in myofascial region of M. biceps brahchii. On the other hand, at the antagonist muscle, the response occurs at 10 min at muscle region, and 20 min, 24 and 48 hr at the myofascial region. Therefore, our results suggest that, the myofascial region of the antagonist muscle have a delayed response than the agonist muscle.

An interesting finding of our study is that the myofascial regions of the M. biceps and triceps brachii are more sensitive than the muscle belly to the mechanical pressure. Our results are inconstinent with the findings are presented Andersen et al. (2006) indicating that specific muscle belly sites were more sensitive to pressure stimulation. Discrepancies between the present and previous studies may have been due to regional differences, since Andersen et al. measured the PPTO at the muscle and myotendinous tissue of the tibialis muscle following eccentric exercise. On the other hand, Baker et al. (1997) showed that the sites close to the distal and proximal myotendinous junction of the quadriceps muscle were most sensitive to pain. In the present study, we did not find any regional differences at the upper arm on pain tolerance after eccentric exercise, however, it seems plausible that some locations of the different body parts become more sensitive to the pressure-induced pain following eccentric exercise.

Our sport massage protocol is applied to the dominant upper arm as the deep tissue massage for 10 min. Our protocol has been previously shown to be effective in alleviating DOMS by approximately 30% and reducing swelling, although it had no effects on muscle function

(Zainuddin et al. 2005). It has also previously shown that the mechanical hyperalgesia was reduced after the deep massage in sedentary participants (Frey Law et al. 2008). Animal models would suggest that even light stroking can produce an anti-nociceptive response (Lund et al. 2002). Massage-like stimulation in rats increases the endogenous release of oxytocin in the plasma and the periaqueductal gray (PAG), and the antinociceptive effects are prevented by blockade of oxytocin receptors (Agren et al. 1995, Yang 1994). Oxytocin is a hormone that has been shown to increase pain threshold, induce physical relaxation, and lower blood pressure and cortisol levels in rats. Injection of oxytocin into the PAG produces analgesia by activation of opioid receptors in the PAG (Ge et al. 2002). In humans, oxytocin has been shown to relieve low back pain (Yang 1994). Thus, massage may decrease hyperalgesia and pain through activation of descending inhibitory pathways, using the PAG-opioid system and oxytocin. An additional mechanism attributed to the pain relieving effect of massage is the moderate beta endorphin release from brain which lasts about one hour after connective tissue manipulation (Kaada and Torsteinbø, 1989).

Several limitations in our study should be mentioned. Our participants were selected from the athletic group working on football for approximately 9 years. Further studies should be replicate by using the large number of groups of athletes working on different kinds of sports, and different massage protocols to clarify the mechanisms and possible consequences of hypoalgesic effect between short- or long term specific adaptations of the exercise training.

In conclusion, the results of the present study showed that single acute eccentric exercise result the hypoalgesic response at the dominant upper arm, whereas the regional deep tissue massage reduces the response in athletes. Our data strongly suggest a possible role of mechanical stimulation on pain tolerance following eccentric exercise in athletes.

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