Journal of Combat Sports and Martial Arts
© MEDSPORTPRESS, 2015; 1(2); Vol. 6, 7-13
ORIGINAL ARTICLE
DOI: 10.5604/20815735.1174225

The effect of deep tissue massage therapy on delayed onset muscle soreness of the lower extremity in karatekas – a preliminary study

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Key words: delayed onset muscle soreness, massage, karate

Summary

Introduction. Delayed onset muscle soreness is an effect of physical activity. DOMS is manifested by mechanical muscle hyperalgesia, occasional resting pain, and altered motor control. There are different strategies to alleviate delayed onset muscle soreness i.e. nutritional intervention, ice, heat, massage, anti-inflammatory drugs and stretching. The aim of this study was to examine the effect of deep tissue massage on delayed onset muscle soreness assessed by pressure pain threshold in martial arts athletes.

Material and methods. 11 karate fighters were subjected to weight training, and then to a series of deep tissue massage therapy sessions. All participants compete on national and international level; all subjects were Polish Champions in their weight categories. Pressure pain threshold was measured seven times using an pressure algometer. The first measurement was taken just before weight training, and the last one at 72 hours after exercise.

Results. The pressure pain threshold for rectus femoris muscle decreased significantly 24 hours after weight training and 24 hours after weight training, after the massage session. The pressure pain threshold for gastrocnemius muscle decreased significantly 24 hours after weight training; 24 hours after weight training, after the massage session; 48 hours after weight training and 48 hours after weight training, after the massage session.

Conclusions. Present study suggests a potent effect of deep tissue massage on alleviating delayed onset muscle soreness after weight training in karate.

Introduction

Delayed onset muscle soreness (DOMS) is a common result of physical activity. DOMS is the discomfort and pain that appear while the muscle contracts after doing unusual exercise, usually after performing eccentric forms of training. In addition to being sore, the muscle also feels stiff due to muscle oedema [1]. Scientists are still debating when the signs and symptoms of DOMS appear. According to Valle et al. the first symptoms appear after 6-12 hours after workout and increase until they reach a peak after 48-72 hours. Koh et al. state that the symptoms occur between 12 and 24 hours and reach their peak values between 24 and 48 hours after exercise, while Imtiyaz et al. suggest that pain appears after 8-10 hours post-exercise. However, all authors agree that the symptoms subside between the 5th and 7th day after the exercise [2,3].

Even relatively slight pain due to muscle strain negatively affects an athlete's sports performance and enhances the risk of injury which may stop them from competing for some time [4][5]. Psychological factors such as anxiety experienced during exercise after an injury [6] also play a role. Physical therapist is to help an athlete recover as quickly as possible, speed up regeneration, [7] and prevent injuries [8]. There are many trends in physical therapy and so there are many different methods used to prevent and alleviate muscle pain.

One of the basic and most common methods is stretching. Many people stretch before or after physical activity to prevent injury, reduce pain after exercise or enhance their exercise capacity [9].

Another way to prevent muscle soreness is the use of compression garments. Studies have shown that wearing proper compression garments may reduce muscle damage by 26.7% [1]. Physical therapists also use more direct methods such as vibrations. Studies by Bakhtiary et al. revealed that using vibration before walking on the treadmill may be effective in reducing DOMS and increasing muscle pain threshold [10]. The technique most commonly applied to aid an athlete's recovery is sports massage. Zainuddin et al. applied a 10-minute sports massage session three hours after eccentric exercise of elbow flexors. The massage was found to alleviate the soreness but it did not directly improve muscle function [11].

The aim of the study was to investigate the effectiveness of deep tissue massage in alleviating DOMS as one of the methods currently used by physical therapists. We hypothesized that deep tissue massage has a positive effect on the onset of muscle soreness.

Material and methods

Subjects

A total of 11 male karate fighters were enrolled in the study. All participants compete on national and international level; all subjects were Polish Champions in their weight categories (one of them took 5th place on European Championships and one took 2nd place on European Cup).Three subjects had 1st DAN, eight subject had 2nd KYU. A factor that disqualified athletes from taking part was injury in the last four weeks before the study. The study was conducted in accordance with declaration of Helsinki, approved by the Ethics Committee in University of Physical Education in Wrocław, Poland. Written informed consent was obtained from all particpants prior to inclusion. Morphological data of the participants are summarized in the table below.

Material and methods

Karate fighters were subjected to weight training in line with the planned training unit, using the following weights.

After the training session, a session of deep tissue massage was performed on each karate fighter by the same person that was properly trained in the method. Pressure pain threshold (PPT) was measured as follows: before weight training; immediately after weight training; 24 hours after weight training; 24 hours after weight training, after the massage session; 48 hours after weight training; 48 hours after weight training, after the massage session and 72 hours after weight training. Massage session was repeated at 24 and 48 hours following training completion. Stages of the test are shown in Figure 1.

Table 1. Basic morphological parameters of the participants. Mean values and standard deviation values (± SD)

Age	25 years±7 years
training experience	9.1 years±5 years
height	179.1cm ±10.5 cm
weight	72.6 kg ± 15 kg

Table 2. List of exercises in weight training with weights, number of training sets, repetitions and length of breaks between individual sets

	Exercise	Weight % 1RM	Number of training sets	Number of repetitions	Break
Warm-up	1. Jogging slowly in place		1	3 minutes	
	2. Skip A		2	10 seconds	
	3. Skip C		2	10 seconds	
	4. Bends + bend and twist exercises		2	20 seconds	
	5. Walking lunges		1	1 minute	
	6. Walking sideways		1	1 minute	
	7. Front support with alternating leg pull to the chest		2	15 per leg	
Main part	1. Single-leg squats while standing on a bench		2	15	
	2. Lunges with a bar placed across the back of the shoulders	60	3	10,10, max	90s
	3. Squats with a bar placed across the back of the shoulders	60,70,80,80,80	5	10,8,6,4,max	90s
	4. Single-leg bends		24	1 second	
	5. Bends with a bar placed across the back of the shoulders	60	3	10	90s
	6. Raising heels off the floor keeping toes on the floor using a ledge	50,80,80,80,50	5	25,12,10,max,25	60s
Final part	Stretching muscles of the leg and pelvic girdle				

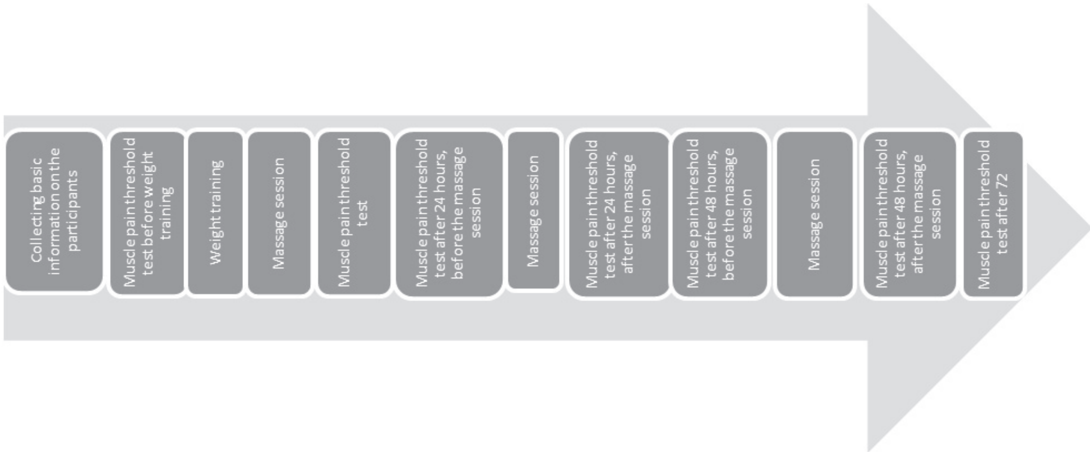

Fig. 1. Test stages

Deep tissue massage – method description

Deep tissue massage (DTM) is one of massage techniques aimed at relieving muscle and fascial tension. The method focuses on releasing the soft tissues within the body (i.e. muscles, tendons, ligaments), and realigning tissue layers as effectively as possible in the areas that are worked on. In deep tissue massage, the therapist works layer by layer, and targets the next tissue layer after the layer above has clearly released. Another important feature of the method is that none or very little lubrication is used by a therapist. Therapists use their forearm, dorsal surface of upper extremity phalanges, lateral surface of upper extremity phalanges (knuckles) and the palmar hand [12,13,14].

Several techniques of Deep Tissue Massage were applied in the study such as releasing incarcerated muscle, relaxing and lengthening muscles, and deep friction massage.

Muscle pain was measured by determining muscle pressure pain threshold, using an electronic pressure algometer (Somedic, Algometer type II, Hörby, Sweden) (Fig. 2) with 1 cm^2 probe tip. The measurements were taken while the subjects were in lying position, at locations that had been marked on the skin, along the muscles length (Fig. 3). Each point at the muscle were tested twice to achieve high reliability. The position ensured that the muscles were relaxed and measurement conditions were optimum. All measurements were taken by the same person.

The algometer was selected for the study because its high reliability was confirmed in other studies by Kinser et al., Park et al. and Kawczyński et al. [15,16,17].

The subjects also scored their pain on a scale from 0 to 10 (0 indicate "no pain", 10 indicate "maximal pain") . Pain scales were filled in three times at 24, 48 and 72 hours, each time before a massage session. Each subject filled pain scale one time during each session.

Statistical methods

Repeated measures analysis of variance was used for the statistical analysis of soreness of individual muscles. Bonferroni test was used for post hoc analysis. The data represents arithmetic means and mean standard deviation. $p<0.05$ was deemed statistically significant. The reliability of pressure algometry has been found to be high (ICC = 0.87, 95%).

Fig. 2. Somedic type II Hörby algometer used to measure pressure pain threshold

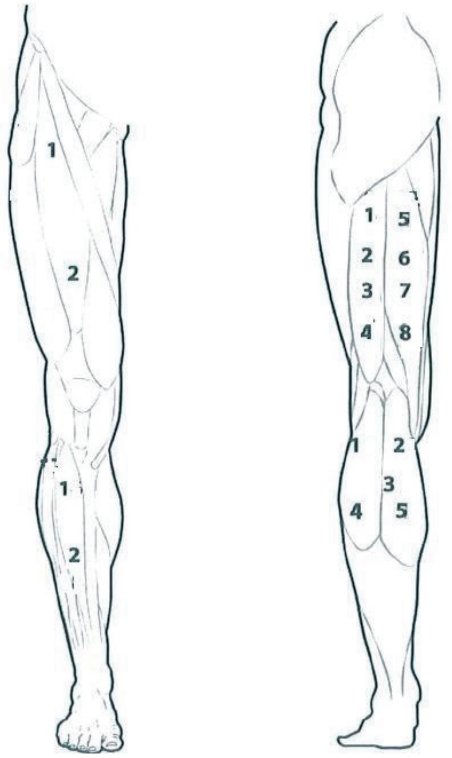

Fig. 3. Pressure pain threshold – measurement locations

Results

The results are presented for four muscles that had been examined. The muscles included the rectus femoris muscle on the front of the thigh; the tibialis anterior muscle on the front of the crus; the gastrocnemius muscle on the back of the crus, and the biceps femoris muscle on the back of the thigh.

The PPT for rectus femoris muscle decreased significantly (muscle soreness increased) from before weight training (1406.2 ± 406,5 kPa) to 24 hours after weight training (1028.5 ± 202.9 kPa) (p=0.009) and to 24 hours after weight training, after the massage session (1110.8 ± 343.7 kPa) (p=0.006). In the remaining sessions PPT returned close to its base level before weight training (muscle soreness decreased) (Table 3).

The PPT for gastrocnemius muscle decreased significantly (muscle soreness increased) from before weight training (1289.5 ± 439.9 kPa) to: 24 hours after weight training (977.9 ± 260.7 kPa) (p=0.04); 24 hours after weight training, after the massage session (878.9 ± 224.8 kPa) (p=0.01); 48 hours after weight training (1074.5 ± 343.3 kPa) (p=0.04); 48 hours after weight training, after the massage session (914.3 ± 339.0 kPa) (p=0.04) respectively. In 72 hours after weight training PPT started to return to its base level before weight training (muscle soreness decreased) (Table 3).

Biceps femoris muscle and tibialis anterior muscle did not show any statistically significant changes of PPT, throughout all experiment (Table 3).

Table 3. Pressure pain threshold [kPa] for investigated muscles

SESSION	PPT for rectus femoris [kPa]	PPT for gastrocnemius [kPa]	PPT for biceps femoris [kPa]	PPT for tibialis anterior [kPa]
before weight training	1406.2 ± 406.5	1289.5 ± 439.9	1423.7 ± 429.1	1499.6 ± 392.5
immediately after weight training	1266.7 ± 415.4	1169.5 ± 385.7	1383.1 ± 398.2	1507.7 ± 376.4
24 hours after weight training, before massage	1028.5 ± 202.9	977.9 ± 260.7	1189.4 ± 314.1	1311.4 ± 303.3
24 hours after weight training, after massage	1110.8 ± 343.7	878.9 ± 224.8	1182.3 ± 350.4	1500.8 ± 376.5
48 hours after weight training, before massage	1266.7 ± 517.1	1074.5 ± 343.3	1213.7 ± 304.4	1330.4 ± 377.1
48 hours after weight training. after massage	1192.9 ± 403.0	914.3 ± 339.0	1234.9 ± 401.6	1433.1 ± 392.6
72 hours after weight training	1116.1 ± 453.3	960.7 ± 302.9	1223.5 ± 393.6	1336.6 ± 509.5

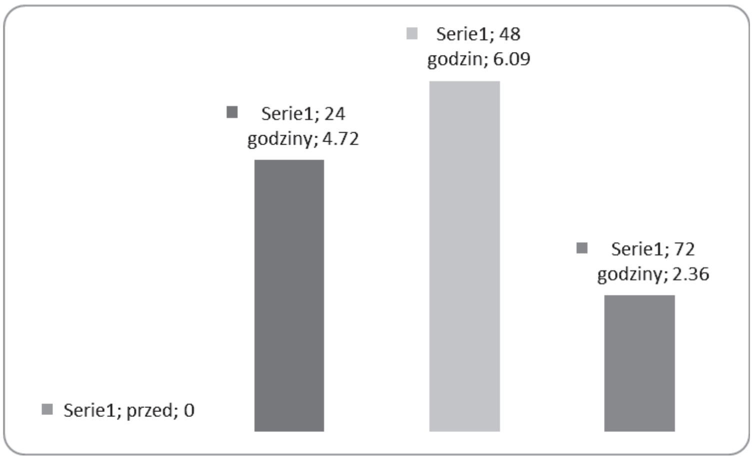

Fig. 4. Athletes' attack activity indices in successive rounds

The pain experienced by the participants (results for the pain scale) during the study is shown in Figure 4. It was shown that the pain significantly increased 24 hours (p= 0.001) and 48 hours (p= 0.001) after weight training. Pain started to decrease 72 hours after exercise, but did not returned to basic level (p= 0.02).

Discussion

The results have shown a decrease in the onset of muscle soreness for rectus femoris muscle and gastrocnemius muscle. It is a positive result which deserves further research with more participants and other disciplines included in the research group.

Injury prevention in sports is the main task of a physical therapist in the coaching staff. Present study is in the field of recent practical studies regard different strategies to alleviate DOMS. Some examples are nutritional intervention [18, 19], ice [20], heat [21], massage [22] and stretching [20]. Additionally, active recovery has also been considered during the search for effective treatment strategies. Active recovery methods include light resistance training [23] high-intensity resistance training [24], whole-body vibration [25] and low-intensity aerobic exercise [26]. It is more than necessary to look for and check different physical therapy techniques to prevent and reduce pain. That is why deep tissue massage therapy was studied.

Our results differ from those of Nieman et al. who did not show any influence of 6-week supplementation with vitamin D2 on DOMS. Supplementation was to improve muscular strength and type II muscle fiber size, which was to reduce post-exercise soreness [27]. However, the results did not show any significant changes of these parameters. Similarly to supplementation, not all forms of massage prove effective, as shown by Jönhagen et al. in their study sports massage treatment had no major effect on the level or duration of pain or on the loss of muscle strength [28].

Application of moist heat and dry heat by Petrofsky et al. proved effective with moist heat used immediately following exercise. The peak of reported pain was reached after 24 hours and then the pain decreased. Dry heat applied immediately after exercise alleviated total pain, but the pain curve was largely unaffected [29] In the study by Ascens?o et al., the athletes were immersed in cold and warm water after exercise. Cold water immersion was found to alleviate DOMS. DOMS peaked at 24 hours and then decreased [30].It is interesting to determine what altered the mechanism of DOMS and to examine why the therapy was effective only for two out of the four muscles under study.

One of the reasons behind the massage's efficacy was increased blood flow in the muscles that are sore from exercise [31]. Increased blood flow helps to nourish the tissues, improves oxygen levels, and washes away metabolic products after exercise [32]. Blood has two important functions. It improves metabolism and thus aids regeneration of the muscle

and at the same time it eliminates metabolic products such as lactic acid that damage the muscles [33].

There is a direct connection between delayed onset muscles soreness and muscle inflammation which is indicated by specific markers i.e. interleukin-6 (IL-6) or Tumor Necrosis Factor (TNF-?) [34]. However, Morasaka has shown that massage reduces inflammation and is effective in alleviating the pain [35].

Deep tissue massage also hydrates the tissues, which reduces friction between muscles and between muscle elements [36] and may improve muscle movement and reduce pain. Similarly to other massage therapies, deep tissue massage affects tactile nerve endings which have a greater diameter and thus transmit signals faster that the „slow„ (pain) nerve endings. This can also be an advantage of DTM.

The question remains why the massage was not effective in all of the muscles under study? Vascular supply of both the rectus femoris muscle and the biceps femoris muscle is derived from the branches of the deep femoral artery, however the branch reaches the muscles in different ways. Lateral circumflex femoral artery is stronger than the medial circumflex femoral artery which is the main one supplying the quadriceps femoris muscle.

No alteration in DOMS in the rectus femoris muscle or the gastrocnemius muscle might be due to the training load algorithm. Exercise done by the subjects are more tiring for the above listed muscles than their antagonists.

Finally, we should recognize the limitations of this study. First, a greater sample size is needed to permit a more generalized interpretation of these results. Second the fact that no control group took part in the present study might be seen as a drawback. However, future studies could easily address this limitation by including untrained subjects and athletes from other disciplines.

Conclusions

1. Present study suggests a potent effect of deep tissue massage on alleviating delayed onset muscle soreness after weight training in karate.
2. Additional research on athletes from e.g. other disciplines targeting the lower extremities or other body regions is clearly needed.
3. Strength and conditioning professionals, including coaches and physiotherapists, should consider deep tissue massage as a method to improve recovery efficiency in karate training.

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Received: 14.12.2014
Accepted: 21.03.2015