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Effects of manual massage on peak torque following an exercise-induced muscle damage protocol of knee extensors in male elite Tae Kwon Do athletes

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Abstract
Manual massage is a popular and widely used modality for recovery after intense exercise consisting an important part of athletic rehabilitation or preparation for training and competition. Objective: To study the possible effects of manual massage on concentric and eccentric peak torque of knee extensors when applied during intervals of an intense exercise isokinetic protocol which causes exercise-induced muscle damage. Methods: Fourteen elite male Tae Kwon Do athletes were tested twice with a week interval between the two measurements (different extremity each). In each session, the participants performed continuous concentric and eccentric isokinetic exercise (6 sets of l0 repetitions, with 2 minutes intervals). Manual massage was applied during breaks to one extremity (massage extremity) while for the other limb (control extremity) the interval was passive. Peak torque was measured 3 minutes after the last set for both extremities (intervention and control). The same test was performed 3 minutes prior to the first set. The best performance was compared between pre- and post-exercise using Analysis of variance with repeated measures. Results: For both extremities, peak torque (concentric and eccentric) was reduced after the exercise protocol. This reduction was lower in the massage extremity but the between extremities (groups) difference was not statistically significant ($p > 0.05$). Conclusion: Application of manual massage during isokinetic exercise intervals did not improve peak torque reduction after knee extensors exercise-induced muscle damage.

Keywords: Manual massage, exercise-induced muscle damage, isokinetic dynamometer, continuous concentric eccentric exercise

1. Introduction

Massage has been defined as ‘‘a mechanical manipulation of body tissues with rhythmical pressure and stroking for the purpose of promoting health and well-being’ [1]. It is considered among athletes, coaches, physicians and therapists, a therapeutic modality that can enhance muscle rehabilitation after vigorous exercise and exercise induced muscle damage reducing exercise-induced muscle strength losses [2-7]. Previous studies have shown that manual massage may attenuate soreness and tenderness associated with delayed onset muscle soreness after downhill walking [8] and after short-term intense continuous isokinetic exercise [9]. However, there is no evidence on its efficacy for a better recovery of strength and functional performance. According to Poppendieck *et al* [4] massage can be effective if the recovery interval is short (up to 10 min). This effect seems to be larger for intensive mixed exercise and for untrained subjects than for athletes. There are very few references’ focusing on the effect of massage on muscle strength production when applied after intense isokinetic exercise on athletes. According to Razeghi & Nouri [10] manual massage is equally effective as cryoterapy on the knee extensor muscles recovery and isokinetic parameters in Soccer players. However, even if massage effect was studied as a warm- up procedure before [11,12] and after exercise [3], no reference could be traced relating to its positive efficacy as a therapeutic modality when applied during intervals of exercise. Since athletes do concentrate on fast rehabilitation after vigorous exercise sessions, the main purpose of this study was to examine the effect of manual massage when it is administered between the sets during short-term intense continuous concentric-eccentric isokinetic exercise.

2. Materials and methods

2.1. Subjects

Fourteen elite male Tae Kwon Do athletes with mean age 21.8± 2.62 years, mean height 179.9 ± 8.48 cm, mean body weight 73.7 ± 10.05 Kg and mean training athletic experience 10,85 ± 3.46 years) volunteered to participate in the study. Training schedules were similar for all athletes who were at the same (national) level. The inclusion criteria were as follows: (a) Male subject professional athletes and (b) Age range between 18-25. The exclusion criteria were: (a) conduction of any strengthening exercises on the day before the tests, (b) musculoskeletal injury during the last six months and (c) background of knee trauma and / or surgery. General characteristics of the participants are presented in table 1.

Table 1: Demographics of the two Groups

	Mean	SD
Age (Years)	21.8	2.62
Height (cm)	179.9	8.48
Body Weight (Kg)	73.7	10.05
Training Athletic Experience (Years)	10.85	3.46

Training consisted of 6 sessions per week, for approximately 2 hours each. The athletic season lasts a typical 11 months period in a year. Subjects reported no musculoskeletal injuries of the lower limbs which could prevent them from performing maximal isokinetic contractions. None of the athletes had been doing progressive resistive exercise the day before the tests. They underwent a thorough clinical knee examination before the test. All subjects were informed of the test procedure, purpose and any known risks and signed a consent form.

Both lower limbs were studied where one limb served as the intervention (by random selection) and the other as the control. Prior to the test conduction a measurement of concentric and eccentric peak torque took place in both legs in order to detect any between-legs differences. Independent sample t-test revealed no statistically significant differences in the mean values of concentric ($p=.31$, $p>0.05$) and eccentric ($p=.64$, $p>0.05$) peak torque between the two legs. In the previous, concentric and eccentric isokinetic exercise for knee extensors were executed with manual massage administered between the intervals by an experienced therapist. The control extremity performed the same isokinetic protocol but without receiving manual massage during the breaks.

Exercise-induced muscle damage was confirmed through blood test prior to the baseline and 36 hours after the final measurement by creatine kinase (CPK) level in blood serum.

2.1 Instrumentation

Measurements were made with Cybex Norm (Lumex, Inc. Ronkonhoma, NY, USA) which allows continuous concentric-eccentric isokinetic movements at an angular velocity of 60°/s.

2.1 Procedure

Before each session, each subject underwent a·10-min warm-up in stationary bicycle and 5-min passive stretching for knee extensors. All tests were performed from the seated position in the apparatus with hip flexion angle of 80°. Standard stabilizing belts for the trunk and pelvis were used and the athletes crossed their arms over their chest. Subject's thigh was stabilized with Velcro straps to prevent any unnecessary movement. The resistance pad was placed proximally to the ankle joint. The axis of rotation of the dynamometer was carefully aligned with the approximate knee joint axis of rotation (posterior aspect of the lateral femoral condyle). For all subjects the motion ranged from 0° (full extension) to 90° of knee flexion. Visual feedback of moment versus time was provided during the test. Furthermore, the subjects were instructed to work as hard as possible in both directions of the movement. No further verbal motivation was given during the test.

Each individual visited the center four times. The first visit was dedicated for familiarization with the system by executing several submaximal and maximal bouts. A week later the bilateral concentric and eccentric peak knee extension torque was measured at 60°/s. At the same occasion subjects received an explanation of the study. The last two visits were dedicated to data collection. In the first one extremity was measured and in the second (last visit) a week later, the other. Selection for grouping was random.

For the massage group the testing protocol consisted of 3 maximum concentric and eccentric efforts (reciprocal) of knee extensors. Maximum peak torque of the concentric and eccentric contraction was recorded. Best effort for both types of exercise was recorded as pre-exercise peak torque. After a 3-minutes break the program was commenced. Six sets of ten repetitions each, with two-minute breaks were conducted. During breaks manual massage to the knee extensors was performed. Three minutes after having massaged the extremity (at the end of the sixth set), 3 maximal concentric and eccentric efforts of knee extensors were again performed in order to determine post-exercise peak torque. The best performance was recorded for the study protocol. The same protocol was used for control group but without the massage.

Manual massage for the study group was performed for 2 min and consisted of: effleurage for 30 sec, petrissage for 50 sec, superficial warming friction for 10 sec and pincement and slapping for the remaining 30 sec. The massage protocol included the following types of application: Effleurage, which represented a light stroking (sliding) movements, covering the whole part to be massaged. It was applied rhythmically in the direction of the venous and lymphatic flow, using the palms alternatively. Petrissage, which was applied with fingers and thumb grasp where the muscle was being lifted and released alternately and rhythmically. Superficial warming friction, where the palms were placed on the skin and rub it round and quickly. Pincement, where the palms were placed vertically above the part to be massaged, lightly and rapidly picking up the tissue with thumb and fingers. Finally, slapping, where the therapist used the entire palm surface and lightly but rapidly slapped the part to be massaged.

2.2 Statistical analysis

Data were analyzed using SPSS for Windows, Version 17.0 (SPSS Inc., Chicago, IL, USA). For the demographic characteristic of participants, descriptive and frequencies analysis were applied. Between groups, differences related to the baseline measurements were checked with the independent samples t-test. No statistically significant differences in the mean values were found between the two groups (extremities) in any of the baseline measurements. For changes in concentric and eccentric peak torque the repeated measures ANOVA was applied to each dependent variable. The between-groups factor was assessed at two levels (Intervention and control extremity), and the repeated measures factor also at two levels (baseline measurement and final measurement). The level of significance was set at p <.05

3. Results

Repeated measures Analysis of variance did not revealed any significant group × time interaction for changes over peak concentric torque (PCT) $F_{(1.00)}$=.761, p>.05, nor over peak eccentric torque (PET) $F_{(1.00)}$=.217, p>.05. A main effect on measurements on the "time of measurement" factor was observed over peak concentric torque $F_{(1.00)}$=174.361, p<.001 and over peak eccentric torque $F_{(1.00)}$=90.218 p<.001. In contrast, there was no significant effect of group factor measurement over PCT, $F_{(1.00)}$=.040, p>.05 nor PET $F_{(1.00)}$=.065, p>.05. PCT and PET diminished in both groups (extremities) after exercise. However, from Table 2 and Figure 1, it seems that the reduction was smaller to the intervention foot related to the control foot, but this difference was not statistically significant.

Table 2: Mean (+/- SD) for extension isokinetic concentric and eccentric peak torque values (Nm) for the two extremities (intervention and control) at pre and post-test

Extremities	Intervention		Control	
	Pre	Post	Pre	Post
Concentric torque (Nm)	199.71 ± 34.7	131.57 ± 25.6	202.28 ± 42.2	124.50 ± 27.5
Eccentric torque (Nm)	307.07 ± 67.8	204.64 ± 46.8	296.64 ± 68.4	183.64 ± 52.4

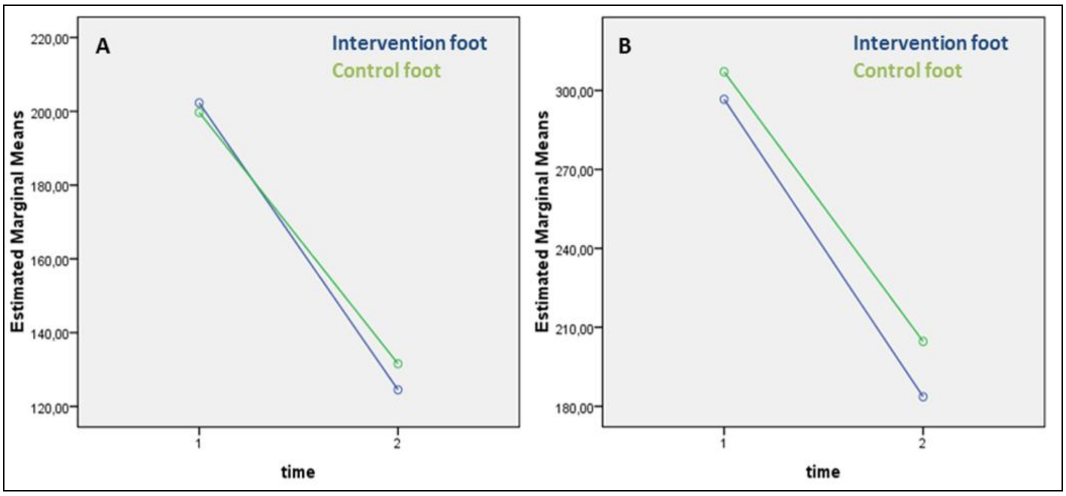

Fig 1: Interaction of "time of measurement" and "group" factors for: A concentric and B eccentric peak torque.

4 Discussion

Quick recovery after short-term and intense exercise is critical for athletic performance [2, 11]. Both athletes and coaches believe that massage has a positive effect on maximizing performance [4, 5, 12]. Although not in doubt, there is not enough scientific evidence on the efficacy of massage in the context of performance enhancement [4, 5, 13, 14].

The aim of this study was to investigate the effect of manual massage on the peak torque after short-term intense continuous isokinetic exercise when applied during breaks between sets. We applied manual massage between sets in order to study its influence on post exercise maximum peak torque for concentric and eccentric exercise for knee extensors. A continuous concentric- eccentric cycle protocol was chosen because the true nature of muscle function involves continuous stretching-shortening or shortening-stretching cycles while activated [15, 16]. In natural motions such as running or jumping, knee extensors are under cyclic muscle action [17].

In this study we chose to apply effleurage, kneading, superficial warming friction, slaps and pincement [18, 19]. Effleurage and kneading, help to reduce post exercise tension, increase blood circulation and enhance recovery after vigorous exercise [20]. Superficial warming friction with the palm of the hand is used to tone muscles [19] after the possible relaxing effect of effleurage and kneading. The last phase is with slapping and pincement to stimulate the exercising muscles and prepare them for maximum performance [20].

The results of this study did not reveal any positive effect of manual massage in performance recovery. Concentric peak torque was diminished to 131.57 Nm (from 199.71 Nm) in intervention foot and to 124.50 Nm (from 202.28 Nm) to control foot, (Table 2). This reduction corresponds to 34,17% for the intervention foot and to 38,61% for control foot. Furthermore, eccentric peak torque was diminished to 204.64 Nm (from 307.07 Nm) in intervention foot and to 183.64 Nm (from 296.64 Nm) to control foot, (Table 2). This reduction corresponds to 33,38% for the intervention foot and to 38,17% to control foot. In conclusion, we could say that there was a tendency of positive effect on intervention foot in both concentric and eccentric peak torque, but the differences between the two legs was not statistically significant and thus we cannot suggest that the implementation of manual massage between the sets consist an effective treatment for performance recovery after intense exercise.

Only a few studies have examined the possible influence of manual massage in recovery after vigorous exercise [10, 11]. Some researchers suggest that manual massage has a positive effect on the delayed onset muscle soreness (DOMS) and to muscle function [8, 9]. However, there is not enough evidence proving the existence of any positive effect on muscle strength. [2, 8, 9, 14]. According to a meta-analysis by Poppendieck *et al*, [5] the effects of manual massage on performance recovery are related mostly with untrained subjects than for athletes. Shin *et al*. [21] found that massage on the gastrocnemius muscle after exercise-induced muscle damage; can improve muscle strength and proprioception by influencing the superficial layer but subject in this survey was not athletes.

In contrast to the above Razeghi & Nouri [10] applied a similar exercise protocol of isokinetic exercise for knee extensors as the one applied in the present study and they found a positive effect of massage on peak torque in soccer players. The exact mechanisms by which manual massage could influence strength recovery are unknown or obscure [2, 5]. When manual massage is compared to exercise, some researchers agree that light exercise may increase blood flow (muscle pump), and therefore may be more effective than massage in terms of recovery after strenuous loads [4, 13]. On the other hand, the effects of massage on short term recovery from muscle fatigue are insufficient and contradictory. Ask *et al*. [22] and Balke *et al*. [24] indicated positive effects and have implied that massage could aid short-term recovery. Total power, peak power and peak power output increased after applying manual massage for ten minutes during break between two 45-second Wingate anaerobic tests in comparison with passive break [24]. But other studies have found either negative or no effects [2, 8, 9, 14, 25, 26]. Tiidus and Shoemaker [27], reported that massage for four days did not improve the recovery of quadriceps isokinetic peak torques. Drews *et al*. [17], also reported that there is no effect after 30 minutes of daily massage in the performance or recovery of elite cyclists.

Besides the physiological mechanisms, one must consider psychological effects of massage on the participant. Studies on the effect of manual massage on athletic psychology suggest that massage has a positive psychological effect, although researchers point out methodological issues [2]. For example, Tiidus and Shoemaker [27] showed that participants had a strong opinion regarding the efficacy of manual massage.

5. Conclusions

Application of manual massage during isokinetic exercise intervals did not improve peak torque reduction after knee extensors exercise-induced muscle damage. Manual massage effect on performance recovery of elite athletes remains to be elucidated.

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