

Sports Massage After Eccentric Exercise

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Background: The use of sports massage is very common in the athletic community. However, only a few studies have shown any therapeutic effect of massage.

Hypothesis: Sports massage can improve the recovery after eccentric exercise.

Study Design: Prospective randomized clinical trial.

Methods: Sixteen subjects performed 300 maximal eccentric contractions of the quadriceps muscle bilaterally. Massage was given to 1 leg, whereas the other leg served as a control. Subjects were treated once daily for 3 days. Maximal strength was tested on a Kin-Com dynamometer, and functional tests were based on 1-leg long jumps. Pain was evaluated using a visual analog scale.

Results: There was a marked loss of strength and function of the quadriceps directly after exercise and on the third day after exercise. The massage treatment did not affect the level or duration of pain or the loss of strength or function following exercise.

Conclusion: Sports massage could not improve the recovery after eccentric exercise.

Keywords: massage; eccentric; delayed onset muscle soreness (DOMS); recovery

The request for sports massage among competitive athletes has seemed to increase during the past years. Many top-level athletes consider this treatment as enhancing their recovery after training and competitions and as protection from overuse injuries. Specifically, massage is believed to reduce the risk of delayed onset muscle soreness (DOMS) and to reduce the decrease in muscle strength and function seen after intense exercise. Also, sports massage is sometimes used in an attempt to treat minor muscle injuries and is given as a prophylactic therapy for these injuries. There are several types of massage, and a massage session often includes different kinds of strokes. The effleurage and petrissage technique that is used in this study is very common when athletes are treated. In sports massage, the kneading of the muscles is considered to be harder than that used in ordinary massage.

It has been shown that intense eccentric exercise may reduce maximal muscular strength by 30%. This strength reduction is probably caused by muscle damage on the sarcomeric level, where the sarcomeres are violently elongated.⁵ DOMS normally follows unaccustomed eccentric exer-

cise, and the peak of muscle soreness is seen 24 to 72 hours after exercise.^{3,6,7}

To prevent both loss of muscle strength and DOMS, sports massage has gained increased popularity in the athletic community.² Although sports massage is widely used among athletes, only a few studies have shown any therapeutic effect of massage.¹⁶

However, vasodilatation in skin tissue produced by massage was recently shown to be caused by the release of neuropeptides.¹² Calcitonin gene-related peptide (CGRP) and neuropeptide Y (NPY), representing the sensory and autonomic nervous systems, respectively, are known to be potent vasoregulatory neuropeptides.⁴ Moreover, these peptides have been shown to be involved in the modulation of pain.^{18,21} Thus, it is interesting to study whether sports massage may interfere with these peptides.

The aim of this study was to examine the potential ability of sports massage in reducing DOMS, functional loss, and decreased muscle strength and to modulate the levels of neuropeptides in the muscle after intense eccentric exercise.

MATERIALS AND METHODS

Sixteen subjects, 8 men and 8 women, participated in the study. Their mean age was 28 years (range, 20-38 years), and they were all healthy, having no injuries, at the time of the study. All subjects were used to different kinds of sports; they were recreational athletes and exercised about

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2 to 3 times per week. The study was approved by the ethical committee at the Karolinska Institute in Stockholm (approval number 99-251) All subjects avoided hard exercises 1 week before the investigations. Warming up included 10 minutes of cycling on an ergometer cycle and mild stretching of the thighs.

Eccentric Exercise

Subjects were seated in a Kin-Com dynamometer (Chattecx Corp, Chattanooga, Tenn) with the angle of the hips at about 100°. The pelvis and the thigh were anchored with a belt, and the distal part of the lower leg was anchored to the level of the dynamometer. The axis of rotation was through the knee joint. For each thigh, the quadriceps muscles performed 300 maximal eccentric contractions at an angle of 10° to 90° in the knee joint, with a velocity of 180°/s. Only eccentric contractions were performed. The Kin-Com dynamometer rotated the leg back to the starting position after each contraction while the subjects relaxed. The subjects were able to follow the exercise procedure on the computer screen and thus got immediate feedback after each contraction. They were also encouraged by the test leader to perform their best during the session. After a few minutes of rest, the same exercise was performed on the other leg. The order of which leg to be used was randomly chosen. The exercise on the Kin-Com dynamometer lasted approximately 30 minutes. After the exercise, the subjects were allowed to rest for a few minutes and drink some water.

Massage

Within 10 minutes after the exercise, all subjects were treated with sports massage by an experienced sport physical therapist. One leg was randomized to massage, and the other leg did not receive any treatment at all. Massage oil ("Dr Schupp," BOFA, Stockholm, Sweden) was used. During the therapy, the subjects lay supine on a bench, and the entire frontal thigh was massaged. The legs were shaved if needed. The massage started with 4 minutes of effleurage, which is a light massage, and was completed with 8 minutes of petrissage. Petrissage is a technique in which the muscle is kneaded more firmly. Massage was given directly after the exercise and once daily for another 2 days.

Strength and Functional Testing

Before and after the exercise, the subjects performed strength and functional testing. The tests were repeated on the third day. The maximal strength was tested with the Kin-Com dynamometer. Three concentric maximal contractions at a speed of 180°/s were tested. This is a method that is commonly used and has been shown to be highly reproducible.¹¹ Maximal torque between 10° and 90° of knee flexion was noted, and the highest value of these was taken as the result. Each subject made 3 maximal 1-leg vertical long jumps on each leg. The best performance of each leg was measured.

Visual Analog Scale Scoring

The subjects rated the pain and discomfort of both legs on a visual analog scale (VAS). They were instructed that on this scale, 0 is no pain or discomfort and 10 is the worst pain imaginable. The subjects had to estimate the pain on this scale before and after the exercise, as well as before and after the massage sessions. The subjects were also asked to estimate how many days the pain and discomfort from their legs lasted. This was done by noting on a questionnaire the date when there was no remaining pain for each leg.

Microdialysis of CGRP and NPY

Using microdialysis, the quadriceps muscles of the first 8 subjects were analyzed for NPY and CGRP. The distal part of the vastus lateralis muscle at a point approximately 10 cm proximal to the knee joint was chosen. The skin and underlying subcutaneous tissue were anesthetized with 1 mL of prilocaine, 10 mg/mL (Citanest, Astra Läkemedel, Södertälje, Sweden). A 1.4-mm puncture needle was used to introduce a CMA 60 microdialysis catheter (CMA Microdialysis AB, Solna, Sweden) parallel to the muscle fibers. The membrane is made of polyamide with a diameter of 0.6 mm and a length of 30 mm; the cutoff is 20.000 d. The catheter was connected to a CMA 107 microdialysis pump (CMA Microdialysis AB, Solna, Sweden), and the infusion speed was selected at 5 µL/min. Isotonic and sterile perfusion fluid was used. After flushing the system for 30 minutes, 4 samples were taken during a 2-hour period.

The dialysis was performed directly after the exercise and massage treatment on the first day, on the third day, and after 2 weeks. The neuropeptides were analyzed using radio immunoassay, as described elsewhere.¹

Statistics

Data for strength and jump tests were analyzed by analysis of variance (ANOVA), repeated measurements design, including 2 dependent factors—treatment (treated, non-treated) and time (before, directly after intervention, and 3 days after intervention). All tests were 2-sided and performed at a significance level of .05.

Change over time for strength and the jump tests was tested by multivariate ANOVA.

Data for VAS were analyzed by Friedman ANOVA, a nonparametric test, testing for systematic change in pain over time. The number of days with delayed soreness was analyzed by *t* test for dependent samples.

The McNemar χ^2 test for categorized data was used to test the difference in NPY, and the Friedman ANOVA was used to test for the difference in CGRP. The commercially available computer software Statistica (Statsoft, Tulsa, Okla) was used for all statistical analysis.

RESULTS

All 16 subjects completed the study. One subject, who had his legs shaved, got folliculitis that developed into mild

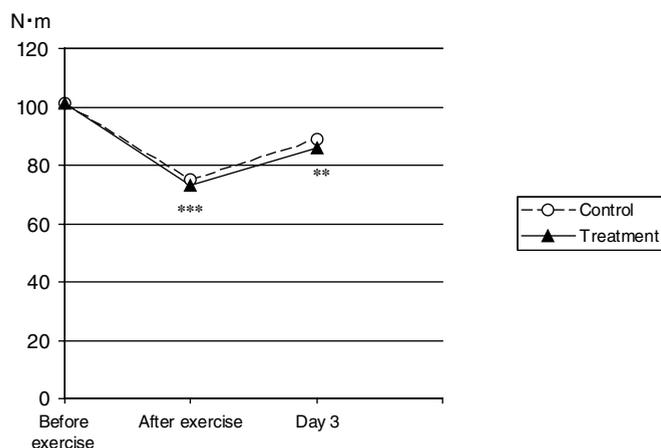


Figure 1. Quadriceps strength measured with a Kin-Com dynamometer before, directly after, and 3 days after a training session including 300 maximal eccentric contractions. Sports massage was given once daily to 1 leg (treatment); the other leg was not treated. No difference between the groups was found ($P < .05$, $N = 16$). The strength was reduced directly after exercise ($***P < .001$) and at day 3 ($**P < .01$).

erysipelas several days after the experiment was finished. He was treated with antibiotics and recovered quickly.

There were no significant differences in maximal strength testing results between the treated leg and control leg before exercise, directly after exercise, and 2 days after exercise ($P < .05$). Mean maximal torque measured by a Kin-Com dynamometer was 101 N·m (range, 59-135 N·m) pre-exercise in the treated leg and 101 N·m (range, 56-127 N·m) in the control leg. After exercise and the first treatment session, torque was 75 N·m (47-120 N·m) and 73 N·m (44-127 N·m), respectively. On the third day, the torque was 89 N·m (42-125 N·m) in the treated leg and 86 N·m (42-127 N·m) in the control leg. The strength was significantly reduced in both groups after exercise ($P < .001$) and on the third day ($P < .01$) (Figure 1).

In the functional 1-legged long jump, the result patterns were similar to those of the strength testing (Figure 2). Before exercise, mean values of the long jumps were 160 cm (range, 108-195 cm) with the leg that was to be treated and 158 cm (range, 111-194 cm) with the contralateral leg. Directly after exercise and massage treatment, the long jumps measured 143 cm (range, 102-190 cm) with the treated leg and 142 cm (range, 103-181 cm) with the control leg. On the third day, the long jumps measured 157 cm (range, 108-189 cm) with the massaged leg and 154 cm (range, 113-187 cm) with the control leg. The results were significantly reduced in both groups after exercise ($P < .001$) but normalized on the third day.

There were 16 subjects included in the study, and they were their own controls. Power calculations, based on paired t tests, were performed using a 10% difference in results as a clinically relevant difference. For the 1-leg jump and the strength tests at day 1 and 3, 3 of 4 comparisons had at least 80% power. The fourth comparison had 76% power.

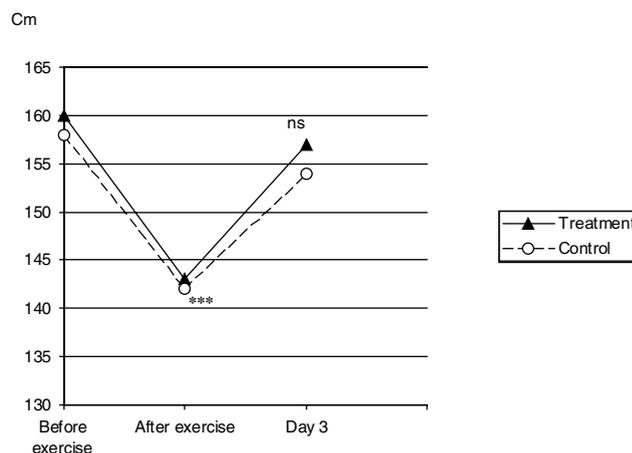


Figure 2. One-legged long jump test before, directly after, and 2 days after a training session including 300 maximal eccentric contractions. Sports massage was given once daily to 1 leg (treatment leg); the other leg was not treated. No difference between the groups was found ($P < .05$, $N = 16$). The results were significantly reduced directly after exercise ($***P < .001$), and at day 3 the results were at the pre-exercise level. ns, not significant.

Pain was evaluated by a VAS from 0 to 10. On the first day directly after the eccentric exercise, the mean value of VAS for the leg to be treated was 2.0 (range, 0-5) and for the control leg was 1.9 (range, 0-5).

After massage treatment, the VAS score was 2.2 (range, 0-6) for the treated leg and 2.1 (range, 0-6) for the control leg. On the third day, the VAS score was 3.1 (range, 1-6) for the treated leg and 3.2 (range, 1-7) for the control leg. No statistically significant differences between the groups were observed with respect to pain. The subjects reported that the soreness remained for 4.2 days (range, 3-5 days) in the treated leg and 4.5 days (range, 3-6 days) in the control leg (not significant).

The measured concentrations of CGRP and NPY were very low, some even below the detection limit. However, there did not seem to be any difference between treated legs and untreated legs.

DISCUSSION

This study demonstrated that sports massage does not appear to give any local effects in reducing DOMS, functional loss as measured with the 1-leg jump, and decreased muscle strength following hard eccentric exercise of the quadriceps muscle. Therefore, it may be questioned why athletes ask for sports massage because there is no apparent physical gain for the described indications.

In this study, both maximal strength tests and functional tests were used to evaluate the effect of massage after exercise. A significant reduction in maximal muscle strength was found directly after the exercise. After 2 days, there was also a distinct reduction of maximal strength. However, treatment with sports massage did not affect this

strength reduction at all; massage was therefore not efficient in influencing local recovery.

One-leg jump is a functional test that has been used in outcome studies of ACL injuries and treatment.¹⁴ This functional test is dependent on muscle strength as well as coordination. Thus, it may also be a test of the recovery of the neuromuscular system involved. As was the case with muscle strength, we did find a significant reduction after heavy eccentric exercise in this test. The massage treatment did not alter this loss of performance. This is interesting because it is very common for athletes to use massage after competitions to enhance the recovery.²

This study was done in an experimental setting; however, athletes might experience DOMS from certain competitive situations, such as cross-country running with a lot of downhill running or after an exhausting volleyball match with a lot of jumping. The follow-up period was only a few days in our study; the subjects were not administered strength and functional tests until the baseline was reached. However, this reflected real-life sporting situations. In an athletic competition, one might have strenuous trials and finals with only 1 or 2 days in-between for rest. There were also some other limitations of the study. The subjects were intermediate athletes who were not used to getting massage. The type of massage used is often given to elite athletes. Athletes who are used to getting massage might react in other ways than in our study. Because of the study design, it was impossible to blind the subjects as to which leg received massage. This might have affected the results, depending on the subject's personal expectations of the treatment.

Our results showing no effects of massage on the muscular performance have also been confirmed by other studies. Tiidus and Shoemaker studied the effect of massage on muscular strength and blood flow after eccentric exercise of the quadriceps.¹⁷ In their study, the quadriceps was treated by massage once daily during 4 days, and the contralateral leg served as control. Immediate postexercise maximal strength measures had declined to approximately 60% to 70% of pre-exercise values in both legs. They found no significant differences of the maximal strength between massage and control legs up to 96 hours after exercise. They also found that massage did not significantly elevate arterial or venous mean blood velocity above resting levels. In a study by Weber et al,¹⁹ subjects were randomized to massage or no massage after eccentric exercise of elbow flexors, and there was no effect of massage on pain or strength reported.

Eccentric exercise is a commonly used method for studying DOMS.^{5-7,9,10} Unaccustomed eccentric exercise causes rupture and damage of structural proteins in the muscular cell skeleton and is followed by an inflammation in the muscle and pain and soreness appearing after 24 to 72 hours.^{6,7} Our recordings of pain after hard eccentric exercise corresponded with this time sequence. However, this study showed no differences in pain, as scored on a VAS, between the massage-treated legs and the contralateral control legs. Moreover, the treatment did not shorten the duration of soreness in the legs.

In an attempt to measure markers of pain^{13,18,21} and vasoregulation,⁴ the presence of CGRP and NPY was studied by microdialysis and radio immunoassay. The levels were low and in several cases undetectable; thus, the CGRP and NPY results might not be definitive because changes were difficult to detect.

These results may not preclude, however, that massage may have central effects, which could not be detected in the study design that we used. In fact, a few studies using randomization to massage or no massage have shown reduced pain for patients with lower back pain^{8,20} and less DOMS following eccentric exercise of the elbow muscles¹⁵ when using massage.

In conclusion, we did not find that sports massage of the quadriceps muscle had any effect on the local recovery after hard eccentric exercise. Nor did we find any effect on the pain and soreness that normally follow this kind of exercises. This was a study of local effects of massage, but the central effects of massage were not studied and should be considered in future studies.

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