EFFECTS OF MYOFASCIAL RELEASE AFTER HIGH-INTENSITY EXERCISE: A RANDOMIZED CLINICAL TRIAL

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ABSTRACT

Objective: The usefulness of massage as a recovery method after high-intensity exercise has yet to be established. We aimed to investigate the effects of whole-body massage on heart rate variability (HRV) and blood pressure (BP) after repeated high-intensity cycling exercise under controlled and standardized pretest conditions.

Methods: The study included 62 healthy active individuals. After baseline measurements, the subjects performed standardized warm-up exercises followed by three 30-second Wingate tests. After completing the exercise protocol, the subjects were randomly assigned to a massage (myofascial release) or placebo (sham treatment with disconnected ultrasound and magnetotherapy equipment) group for a 40-minute recovery period. Holter recording and BP measurements were taken after exercise protocol and after the intervention.

Results: After the exercise protocol, both groups showed a significant decrease in normal-to-normal interval, HRV index, diastolic BP ($P > .001$), and low-frequency domain values ($P = .006$). After the recovery period, HRV index ($P = .42$) and high-frequency (HF) ($P = .94$) values were similar to baseline levels in the massage group, whereas the HRV index tended ($P = .05$) to be lower and the HF was significantly ($P < .01$) lower vs baseline values in the placebo group, which also showed a tendency ($P = .06$) for HF to be lower than after the exercise. Likewise, diastolic BP returned to baseline levels in the massage group ($P = .45$) but remained lower in the placebo group ($P = .02$).

Conclusion: Myofascial release massage favors the recovery of HRV and diastolic BP after high-intensity exercise (3 Wingate tests) to preexercise levels. (J Manipulative Physiol Ther 2008;31:217-223)

Key Indexing Term: *Heart Rate; Massage; Blood Pressure*

Massage therapy is used as a recovery resource designed to improve sports performance,[1-7] and sports physiotherapists are estimated to devote approximately 45% of the time to giving massages.[8] However, despite the widespread use of massage therapy, inadequate scientific evidence has been published to establish a definitive theoretical framework that explains its physiologic effects.[9]

Exercise has been shown to influence autonomic cardiovascular control. High-intensity exercise may induce an autonomic imbalance characterized by an increase in heart rate (HR) and sympathetic modulation and a decrease in parasympathetic activity. A sustained autonomic imbalance may be associated with a state of overtraining that reduces the performance and well-being of sports people. Sports training produces a cascade of cardiovascular changes that involve various neural and chemical factors at local and systemic level. The aim of these adjustments is to preserve the physical integrity of an individual faced by the high energetic demands of sports activity.[10] These changes in cardiovascular activity reflect an exacerbation of the sympathetic activity of the autonomic nervous system (ANS).[10] The ANS then acts to restore autonomic balance during recovery for a correct assimilation of the training load. Different high-intensity exercise protocols, for example, 3 repetitive Wingate tests, have been used to induce immune suppression,[11] which has been explained by sympathetic stimulation.[12]

Heart rate variability (HRV) reflects the influence of the ANS on the HR.[10,13] Heart rate variability tends to

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progressively decrease with a marked increase in the intensity of exercise.[14] Normalization of these changes at the end of exercise assists the recovery process. Various studies have reported that relaxing therapeutic modalities (eg, biofeedback, meditation, or music therapy) appear to foster a decrease in arterial tension, HR, and even HRV.[9,15,16] Effleurage to the back was reported to decrease HR,[17] and massage therapy of trigger points increased HRV time- and frequency-domain values and decreased systolic and diastolic blood pressure (BP) values in patients with myofascial pain.[18] Touch therapy was found to reduce the high-frequency (HF)/low-frequency (LF) range in healthy subjects.[19]

The aims of the present study were (*a*) to assess the ability of a proposed exercise protocol to induce an autonomic imbalance, and (*b*) to evaluate the short-term effects of a massage therapy session on HRV and BP in active healthy individuals after high-intensity exercise.

METHODS

Sample size estimation was based on the primary end point, that is, the SD of the normal-to-normal interval (SDNN) of HRV at the end of the study, in accordance with a previous study[18] on the effect of manual therapy on HRV. Sixty-two healthy active individuals (37 males and 25 females) from the Sports and Exercise School and Health Sciences School of the University of Granada, Granada, Spain participated in this study from October 2005 to March 2006. Written informed consent was obtained from all participants in this study, which was approved by the ethics committee of the university. All participants had engaged in physical activity for 5 to 10 hours a week during the previous 12 months.

The subjects entered the laboratory at the same time of day on 3 occasions, with a 1-month interval between sessions. All sessions took place between 5 and 9 PM to avoid possible circadian rhythm-induced variations.[20,21] Individuals underwent a medical examination (anthropometric study based on the Yuhasz-Carter skinfold method and resting electrocardiogram [ECG]) and were screened for inclusion criteria (5-10 hours/wk of physical activity, no pharmaceutical drug intake in the past 3 months, nonuse of tobacco or other addictive substances, no signs/symptoms of disease, and no contradiction of high-intensity exercise) at the first session. Familiarization was completed at the second session to ensure that all the subjects knew the protocol and could complete the tasks required (see below), and to establish a reference performance value for comparison with the value obtained at the third (test) session. The subjects received recommendations about dietary intake and were instructed not to exercise heavily during the 24 hours before the test. In the third session, baseline Holter ECG recording and BP measurements were obtained after a 10-minute rest in supine position. The subjects then performed a standardized light warm-up protocol,[22] followed by three 30-second Wingate tests on an ergometer cycle (Monark 834, Varberg, Sweden); according to a previously published protocol,[12] Wingate tests were separated by 3-minute recovery periods. Each exercise test was performed against a braking force of 4.41 J per pedal revolution per kilogram body weight. For safety reasons and to improve exercise tolerance, the 3-minute recovery periods were divided between an initial active recovery phase (pedaling at a controlled 50-W work rate for 90 seconds) and a subsequent passive recovery phase (90 seconds of quiet sitting). After the third Wingate test, there was a 15-minute period of active and passive recovery (10 minutes active/5 minutes passive). The subjects were encouraged to give their maximum performance during the exercise protocol and were offered an incentive (lottery ticket for weekend holiday) if they improved on their performance in the familiarization (second) session. On completion of the exercise protocol, the subjects rested in supine position for Holter recording and BP measurements.

Table 1. *Massage—myofascial induction protocol*

Massage technique	Body area	Approximate time (min)
Long J-stroke	Gastrocnemius	3
Long J-stroke	Biceps femoris	3
Cross hand technique	Thoracolumbar fascia	12
Sustained pressure	Occipital condyles	5
V spread	Frontalis	5
Ear pull	Temporalis	4
Cross hand technique	Quadriceps	8

The subsequent intervention was either a 40-minute sham treatment using disconnected ultrasound and magnetotherapy equipment or a whole-body myofascial release treatment of approximately 40 minutes (precise duration depended on the tissue response observed) using the Barnes[23] and Upledger and Vredevoogd[24] approach (Table 1). The position of the patient and the areas treated were identical in both protocols. The subjects were assigned to each group by using an envelope randomization method, matching the groups for sex. All massages were administered by the same chartered physiotherapist using conventional oil (sweet almond oil, Acofarma, Barcelona, Spain) when necessary. After this intervention, Holter and BP measurements were again performed with the patient resting in supine position.

Heart Rate Variability and BP Measurement

Short-term HRV in time (SDNN, square root of mean squared differences of successive normal-to-normal intervals and HRV index [number of all normal-to-normal intervals/maximum of the all normal-to-normal intervals]) and frequency (LF component, 0.04-0.15 Hz; HF component, 0.15-0.40 Hz, and LF/HF ratio) domains was obtained using a 3-channel (1, right manubrial border of sternum-left anterior

Table 2. *Cardiovascular and anthropometric baseline values of study groups*

	Control group (n = 30)	Massage group (n = 32)	*P*
Diastolic pressure (mm Hg)	69.9 ± 7.1	66.9 ± 7.1	.12*
Systolic pressure (mm Hg)	119.2 ± 15.4	121.5 ± 14.0	.64
HR (beats/min)	67.3 ± 13.6	67.9 ± 10.9	.82
Body mass index (kg/m^2)	22.4 ± 2.1	22.2 ± 2.2	.69
% Body fat	14.7 ± 5.9	16.5 ± 4.8	.18*

Data are expressed as mean ± SD. Values at different time points were tested by GEEs.

* $P < .05$.

Table 3. *Comparison of HR and HRV between groups at different time points*

	Control group (n = 30)	Massage group (n = 32)	*P* (GEE)
HR (beats/min)			
Baseline	67.3 ± 13.6	67.9 ± 10.9	.81
Postexercise	98.8 ** ± 12.4	101.0 ** ± 7.7	
Postrecovery	74.5 ** ± 11.9	74.3 ** ± 9.5	
SDNN (ms)			
Baseline	96.3 ± 56.0	80.3 ± 38.8	.28
Postexercise	48.4 ** ± 21.2	55.7 ** ± 48.1	
Postrecovery	90.5 ± 53.4	88.9 ± 67.8	
HRV index			
Baseline	10.0 ± 3.8	8.6 ± 2.5	.13 *
Postexercise	3.9 ** ± 1.4	3.5 ** ± 1.1	
Postrecovery	8.1 ** ± 3.2	8.2 ± 3.2	
LF (ms^2)			
Baseline	181.3 ± 74.9	173.7 ± 64.9	0.70
Postexercise	145.2 ** ± 52.8	153.2 ** ± 70.2	
Postrecovery	182.5 ± 53.4	175.9 ± 47.8	
HF (ms^2)			
Baseline	173.3 ± 53.2	148.7 ± 45.0	.18 *
Postexercise	160.6 ± 59.1	153.4 ± 95.0	
Postrecovery	133.8 ** ± 55.9	147.6 ± 68.5	
LF/HF			
Baseline	1.0 ± 0.6	1.2 ± 0.6	.33
Postexercise	0.9 ± 0.9	1.0 ± 1.1	
Postrecovery	1.4 ** ± 0.9	1.2 ± 1.0	

Data are expressed as mean ± SD. Values at different time points were tested by GEEs. *LF/HF*, Ratio of LF to HF.

* GEE, $P < .2$ (significant interaction).

** Bonferroni correction, $P < .05$ vs baseline value.

auxiliary line of the sixth rib; 2, left manubrial border of sternum 1 in to the right of xiphoid process; 3, center of manubrium-left midclavicular line of the sixth rib) ECG (Norav Holter DL 800; Braemar, Burnsville, Minn), taking 5-minute recordings with the subject at rest and with no external stimulation at 3 time points: baseline, postexercise, and postrecovery. The spectral analysis was calculated with NH300 Software (Norav, v.2.70) using Fast Fourier transform algorithms. The sampling rate was 128 samples per second, and the frequency filter was set at 0.05 to 60 Hz. Because of the low sampling rate, the software used an interpolation algorithm to improve r-peak detection. These variables were studied by an investigator blinded to the intervention status of the patients. An Omron HEM-737 validated automatic oscillometric device (Kyoto, Japan) was used for BP measurements.[25]

Statistical Analysis

A repeated measures design was used with 2 fixed effect factors (group, groups and time, 3 times) and a random effect factor (participants) nested in group. The classic analysis of this repeated measures design was not indicated because, in many cases, the sphericity hypothesis was not met; therefore, a generalized estimating equation (GEE) model was used.[26] The model included 2 main effects (group and time) and the interaction of these effects; interaction was considered significant at $P < .20$ to avoid losing any relevant effects. When the interaction was significant, comparisons were made between groups at each time point and between time points for each group using Bonferroni correction. When necessary, data were log transformed to achieve homogeneity of variance. In the comparisons, $P < .05$ was regarded as significant. The STATA 9.1 package (Stata Corp, College Station, Tex) was used for the statistical analysis.

RESULTS

Of the 180 individuals who volunteered for the study, 87 met the study inclusion criteria, and 68 of these were randomly selected for enrollment. Six of these subjects (2 from exercise group and 4 from control group) were subsequently lost to the study, 1 for disease onset and 5 for failure to attend sessions. Therefore, 62 individuals were finally accepted into the protocol, with a mean age of 21.1 ± 2.16 years, weight of 67.5 ± 1.4 kg, height of 174.3 ± 8.8 cm, body mass index of 22.3 ± 1.4, and body fat percentage of 15.6% ± 5.4%. No differences in anthropometric or cardiovascular characteristics were found between groups (Table 2).

Effects of Exercise and Massage on HRV

No significant differences in baseline HRV values were found between groups (Table 3). After the exercise protocol, both groups showed a significant increase in HR ($P < .001$) values; a decrease in SDNN, HRV index ($P < .001$), and LF ($P = .006$) values; and no significant change in HF ($P = .56$) or LF/HF ($P = .54$) values (Table 3). Heart rate variability index ($P = .13$) and HF ($P = .18$) were considered significant in the GEE model. After the recovery period, HRV index values were similar ($P = .42$) to baseline levels (8.6-8.2) in the massage group but tended to be lower ($P = .05$) than baseline levels (10.0-8.1) in the placebo group. After the recovery period, HF was similar to baseline ($P = .94$) (148.7-147.6 milliseconds^2) and postexercise ($P = .82$) (148.7-153 milliseconds^2) values in the massage group, whereas HF values in the placebo group were significantly

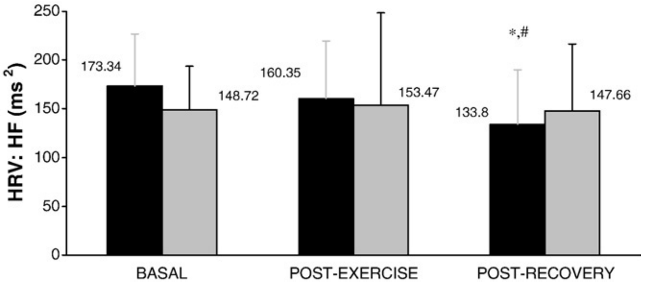

Fig 1. *High-frequency spectral domain of HRV at different time points. Placebo group is the dark bar; massage group is the light bar.* **Significant change vs baseline value* (*P < .05, Bonferroni correction*). #*Close-to-significant change vs postexercise value* (*P = .06, Bonferroni correction*).

Table 4. *Comparison of BP between groups at different time points*

BP	Control group (n = 30)	Massage group (n = 32)	P (GEE)
DBP (mm Hg)			
Baseline	69.9 ± 7.1	66.9 ± 7.9	.13 *
Postexercise	62.3 ** ± 9.6	63.2 ** ± 7.6	
Postrecovery	66.7 ** ± 7.1	65.9 ± 6.5	
SBP (mm Hg)			
Baseline	121.5 ± 14.0	119.9 ± 15.4	.14 *
Postexercise	119.8 ± 13.9	122.3 ± 15.2	
Postrecovery	116.4 ** ± 11.6	113.5 ** ± 11.6	

Data are expressed as mean ± SD. The values at different time points were tested by GEEs. *DBP*, Diastolic blood pressure; *SBP*, systolic blood pressure.

* Significant interaction (P < .2) in GEE model.

** Bonferroni correction, P < .05 vs baseline value.

lower (P < .01 vs baseline) (173.3-133.8 milliseconds^2) or showed a tendency to be lower (P = .06 vs exercise) (173.3-160.6 milliseconds^2) (Fig 1).

Effects of Exercise and Massage on BP

The groups did not differ in baseline BP values (Table 2). After the exercise protocol, diastolic BP was lower (P < .001) in both massage and placebo groups, whereas systolic BP was similar (P = .78) to baseline levels (Table 4). In the GEE model, significance was found for systolic (P = .14) and diastolic (P = .13) BP values. After the recovery period, diastolic BP returned to baseline levels (P = .45) (66.9-65.9 mm Hg) in the massage group but remained significantly (P = .02) lower (69.9-66.7 mm Hg) in the placebo group (Fig 2), whereas systolic BP levels remained significantly below baseline levels in both groups (massage, P = .01; placebo, P = .001).

Discussion

This study shows that massotherapy associated with active recovery can restore balance to the ANS of an individual after intermittent high-intensity exercise. Recovery techniques play a crucial role in this state of autonomic imbalance, which is associated with a risk of cardiac events and even with the sudden death occasionally documented during sports activities.[27-29]

The exercise protocol proposed herein induced a state of autonomic imbalance characteristic of high-intensity exercise,[13] manifesting as a decrease in SDNN, HRV index (time-domain HRV measure),[30-34] and maintenance of HF.[35,36] These findings confirm that the present protocol produces an increase in cardiac sympathetic activity.[13] Thus, a transient vegetative overstimulation is produced, which must be reversed during the recovery phase to eradicate the deleterious effects of exercise.

There are very few published reports on nonpharmacologic approaches to restoring autonomic balance.[37] The massage protocol proposed here proved to be a simple method to restore or maintain preexercise HRV values, as evidenced by HRV index and HF findings, respectively. Results obtained also showed that the HF (HRV frequency domain) is maintained throughout the study in the subjects who received massage. The placebo group showed a lower HF after the sham treatment than at baseline or immediately after the exercise, indicating a delay in the recovery process. A similar lowering of HF has been found after different exercise protocols for males and females[38,39] and was even reported at 1 hour after an exercise protocol.[40] These findings suggest an increased parasympathetic withdrawal in the placebo, but not in the massage group. The influence of postmassage parasympathetic activity on HR, reflected in maintained HF values, may be associated with an improved homeostasis.[41] Sustained parasympathetic influence during the postexercise recovery phase helps to speed recovery, allowing further efforts to be exerted.

Various authors[42-46] reported that the respiratory rate has a crucial role in modulating the HF, questioning the existence of a true parasympathetic vegetative modulation. However, Bartels et al[47] concluded that respiration has no effect on HRV spectral analysis during exercise. Therefore, HRV changes during exercise may indicate a real autonomic modulation of the cardiovascular system. The respiratory rate was not investigated in the present study to avoid the discomfort associated with its monitoring[48] and possible errors produced by the manipulation of breathing, which have been reported in manual therapy studies.[49] Further studies in which the respiratory rate is monitored are required to confirm a definite autonomic effect that is not mediated by respiration.

The results obtained with the present myofascial release protocol are consistent with the findings by other studies[9,17,50,51] on the parasympathetic effects of manual therapy, despite the older age and different characteristics of their study populations. A novelty of the present study is the finding of these effects after high-intensity exercise by a healthy group, because only patients were studied in previous investigations.[8,52,53]

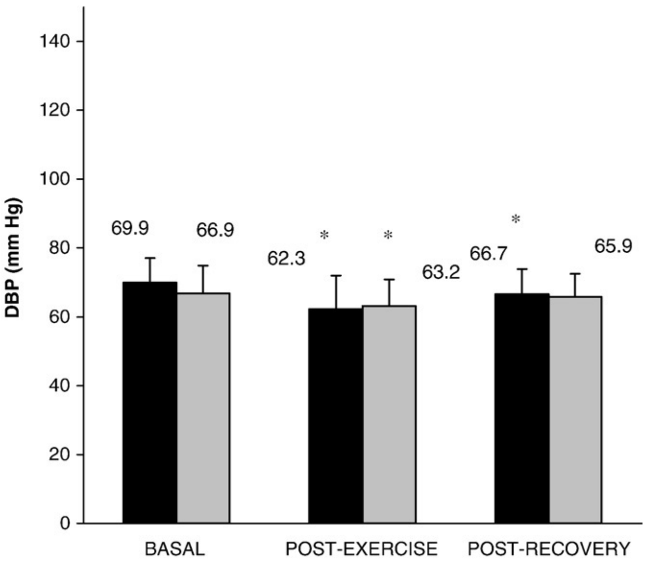

Fig 2. *Diastolic BP at different time points. Placebo group is the dark bar; massage group is the light bar.* **P* <.05 *vs baseline value.*

The mechanism underlying the parasympathetic effect of massotherapy has yet to be elucidated. It is possible that some type 3 and 4 mechanoreceptors[54] mediate the response when stimulated by myofascial therapeutic maneuvers,[55-57] triggering a predominantly parasympathetic vegetative response.[58] A specific group of these mechanoreceptors was recently discovered to be responsible for this type of cardiovascular response to traction stimuli.[59] In the protocol proposed in this article, the predominant maneuver involves sustained pressure traction of tissues.

An important finding of this study was that massotherapy enhances recovery of diastolic BP to baseline values after high-intensity physical exercise. The hypotension produced by this level of exercise, confirmed in the present study, can require a recovery period of up to 2 hours.[40,60-62] Recovery from this hypotension can be improved by active recovery protocols that facilitate a gradual venous return without the interruptions that can give rise to dizziness.[63,64]

The capacity of massotherapy to modify BP levels has been shown in animals.[65-67] Some authors have offered a mixed psychologic-physiologic explanation of the influence of manual therapy on BP.[15,68] The above-described stimulation of the parasympathetic response may be implicated in the BP changes. The sedative effects of massage observed in animal studies[67] have been reported to involve opiate and serotoninergic mechanisms in the reduction of BP,[66] which might also explain the present outcomes in healthy subjects.

Although the exercise protocol was designed to simulate a competitive situation and the recovery was managed by an expert sports physiotherapist, the limitation of this study is that the subjects were not high-level sports people who might possibly show a different behavior. In future studies, it would be useful to vary the massage protocol characteristics, for example, duration, timing, and type and site of maneuvers, to establish the most effective massotherapeutic approach for obtaining a cardiovascular relaxation response.

CONCLUSION

In conclusion, this study identified that application of an active recovery protocol using whole-body myofascial release favors BP and HRV normalization after high-intensity exercise.

Practical Application

- Heart rate variability and BP recovery improved with a session of myofascial release after a physical stress situation compared with sham electrotherapy treatment.

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