ORIGINAL ARTICLE

Cardiovascular Autonomic Modulation After Acute Resistance Exercise in Women With Fibromyalgia

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ABSTRACT. Kingsley JD, Panton LB, McMillan V, Figueroa A. Cardiovascular autonomic modulation after acute resistance exercise in women with fibromyalgia. Arch Phys Med Rehabil 2009;90:1628-34.

Objective: To test the hypothesis that autonomic modulation after resistance exercise (RE) would be reduced in women with fibromyalgia (FM) compared with controls.

Design: Before-after trial.

Setting: Testing occurred in a university setting.

Participants: Women with FM (n=9) and healthy controls (n=9) underwent testing before (pre) and 20 minutes after (post) RE.

Interventions: Not applicable.

Main Outcome Measures: Normalized low-frequency (LFnu) and normalized high-frequency (HFnu) oscillations and the LFnu/HFnu ratio were indicative of sympathetic modulation, parasympathetic modulation, and sympathovagal balance, respectively. Baroreceptor reflex sensitivity (BRS) was also measured.

Results: Variables were similar in both groups at rest. HFnu decreased in controls (pre, 55.0±4.2%; post, 35.0±4.7%; $P<.05$) and increased in women with FM (pre, 57.0±5.7%; post, 63.2±4.6%; $P<.05$). LFnu increased in controls (pre, 43.3±4.4%; post, 63.2±4.8%; $P<.05$) and decreased in women with FM (pre, 41.8±5.6%; post, 35.6±4.7%; $P<.05$). The LFnu/HFnu ratio increased in controls (pre, 0.89±0.17; post, 2.43±0.64; $P<.05$) with no change in women with FM (pre, 0.90±0.22; post, 0.64±0.13; $P=.13$). BRS decreased in controls (pre, 8.78±1.42ms/mmHg; post, 5.49±0.66ms/mmHg; $P<.05$), but not in women with FM (pre, 5.91±1.22ms/mmHg; post, 9.23±2.4ms/mmHg; $P=.16$).

Conclusions: After acute RE, women with FM responded differently from controls, demonstrated by lower sympathetic and higher vagal modulation without altering BRS. These post-exercise responses may be attributed to the altered autonomic responsiveness to physiologic stress that characterizes FM.

Key Words: Autonomic nervous system; Baroreflex; Rehabilitation; Vagus nerve.

PRIMARILY DIAGNOSED IN women, FM is characterized by chronic widespread pain and discomfort when pressure is applied at specific musculoskeletal sites on the body termed, tender points.[1] The characteristics of FM are diverse and include reduced muscular strength and endurance,[2] orthostatic intolerance,[3] parasthesis,[3] irritable bowel,[3] and intolerance to cold.[4] Reports have demonstrated that RE training may help improve quality of life in women with FM.[5]

Recent research has suggested that many of the symptoms of FM may be explained by autonomic nervous system dysfunction.[3] Studies evaluating autonomic nervous system modulation, via HRV, in women with FM have found increased sympathetic activity as well as decreased parasympathetic (vagal) activity at rest[3] and the inability to compensate correctly in response to physiologic stress such as standing[3] and cold exposure.[4] These autonomic abnormalities in FM have been attributed to attenuated spontaneous BRS.[6]

BRS is one of the prime determinants of acute changes in cardiac autonomic modulation.[6] Located within the aortic arch and carotid bodies, the arterial baroreceptors control the acute fluctuations in heart rate via modulation of vagal and sympathetic activities. Cardiovagal BRS modulation is reduced during exercise, but it increases to resting levels 30 minutes after moderate-intensity endurance exercise.[7,8] Interestingly, a greater reduction in overall HRV and vagal tone has been found 20 minutes after acute RE compared with endurance exercise in healthy participants.[9] A reduction in BRS and HRV after exercise significantly increases the relative risk of cardiovascular events because of a reduction in vagal modulation and sympathetic predominance.[9,10] Because women with FM already have reduced HRV and vagal tone at rest, a further reduction in vagal modulation after acute RE may increase their relative risk for cardiovascular events. Therefore, we tested the hypothesis that autonomic modulation at rest and after a bout of RE would be reduced in women with FM compared with healthy controls.

METHODS

Participants

Eighteen sedentary women age 21 to 59 years participated in this study. The participants were classified as clinically diagnosed with FM (n=9) or as healthy controls (n=9). Before any data collection occurred, a diagnosis of FM was confirmed by

List of Abbreviations

1RM	1-repetition maximum
BMI	body mass index
BRS	baroreceptor reflex sensitivity
ECG	electrocardiogram
FM	fibromyalgia
HF	high frequency
HFnu	normalized high frequency
HRV	heart rate variability
LF	low frequency
LFnu	normalized low frequency
Ln	natural log
nu	normalized units
RE	resistance exercise

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a board-certified rheumatologist (V.M.) according to the guidelines outlined by the American College of Rheumatology.[1] Women with FM were recruited via fliers and newspaper advertisements, while the age-matched and weight-matched healthy controls were recruited from the university community. Eight women were premenopausal (4 FM and 4 healthy controls), and 10 women were postmenopausal (5 FM and 5 healthy controls). Women with FM were taking the following medications: lipid-lowering (1), anti-inflammatory (3), progesterone-estrogen replacement (3), birth control (2), antidepressants (3), diuretics (2), and gastric antacid (2). Three of the healthy controls were taking progesterone-estrogen replacement; otherwise, no other medication was being taken. All participants were nonsmokers who had not smoked for at least 1 year, with no known history of cardiovascular disease, diabetes mellitus, or pulmonary disease. Sixteen of the participants had not participated in a regular physical activity program for more than 30 minutes, 3 times a week, for at least 6 months. Two of the healthy controls were considered active, both of whom were currently undergoing a resistance training program. All participants gave written informed consent, which was approved by the Institutional Review Board Committee at Florida State University.

Data Collection

Participants came to the laboratory on 6 different occasions (fig 1). During the first and second visits, participants came to the laboratory to undergo testing for the determination of their 1RM lifts on the chest press and leg extension. Over the next 3 visits, participants were familiarized with proper lifting techniques on 8 other REs, which included the overhead press, leg press, leg curl, biceps curl, abdominal crunch, seated dip, seated row, and lower back hyperextension. During this familiarization period, a resistance load was ascertained that caused the participants to fatigue by 12 repetitions maximum on the 8 REs as well as the chest press and leg extension. Forty-eight hours after the end of the third familiarization visit, participants returned for cardiovascular autonomic function testing (see fig 1).

On the day of the cardiovascular autonomic function test, all participants arrived at the laboratory in the morning between 6 AM and 11 AM to account for circadian rhythm. Participants came to the laboratory at least 3 hours after their last meal, having abstained from caffeinated beverages for 12 hours, strenuous physical activity for 24 hours, and all medication for at least 8 hours. After a 15-minute quiet rest period in the seated position, 5 minutes of cardiovascular variables were collected, which included heart rate, HRV, and BRS. Thereafter, participants performed a 30-minute session of REs, 1 set of 12 repetitions on 10 exercises, following the recommended prescription for adults by the American College of Sports Medicine.[11] The resistance load for the chest press and leg extension was at approximately 60% of the predetermined 1RM. While on the remaining 8 REs, the resistance was sufficient enough to elicit fatigue by the twelfth repetition, as previously determined from the familiarization period. Within 1 minute of finishing the exercise bout, the participants returned to the seated position. Participants rested for 20 minutes, followed by collection of cardiovascular autonomic variables for 5 minutes. To ensure that all participants were breathing at the same frequency during data collection at rest and recovery, a metronome was set at 12 breaths per minute to control for breathing rate. Prior to pre-exercise and postexercise data collection, general levels of pain were assessed using a 10-point numerical scale. The numerical scale used the anchors 0 equal to "no pain at all" and 10 equal to "most pain imaginable."

Strength testing and familiarization. Muscle strength was assessed using MedX[a] machines. For the 1RM, participants warmed up before testing using light resistance loads. Workloads were progressively increased to reach the 1RM, defined as the maximal weight that was moved 1 time through the full range of motion. Two to 3 minutes of rest was given between each attempt. The 1RMs were verified after at least 72 hours of the first determination, and the highest value of the 2 days of testing was used in the analysis for the 1RM. After the 1RM testing, the 2-week familiarization period was used to determine the 12 repetitions maximum on the other 8 exercises. Forty-eight hours after the last familiarization session, the participants came to the laboratory for cardiovascular autonomic function testing, in which all 10 REs were used to evaluate the acute effects of a RE bout on cardiovascular autonomic modulation.

Anthropometry. Body weight was measured on a Seca[b] balance beam scale to the nearest 0.1lb, which was subsequently converted to kilograms for further analysis. Height was measured with a Medart stadiometer[c] to the nearest centimeter. BMI was calculated as weight (kg)/height (m^2).

Autonomic and hemodynamic measurements. Continuous recordings of heart rate were obtained using a modified CM5 electrocardiogram lead interfaced with a Biopac[d] data acquisition system. ECG recordings were sampled at a frequency of 1000Hz and then stored on a computer. Five-minute segments at rest and recovery from exercise were used for data analyses. The ECG was visually inspected for any ectopic beats or artifacts prior to data analyses. Any artifacts or ectopics

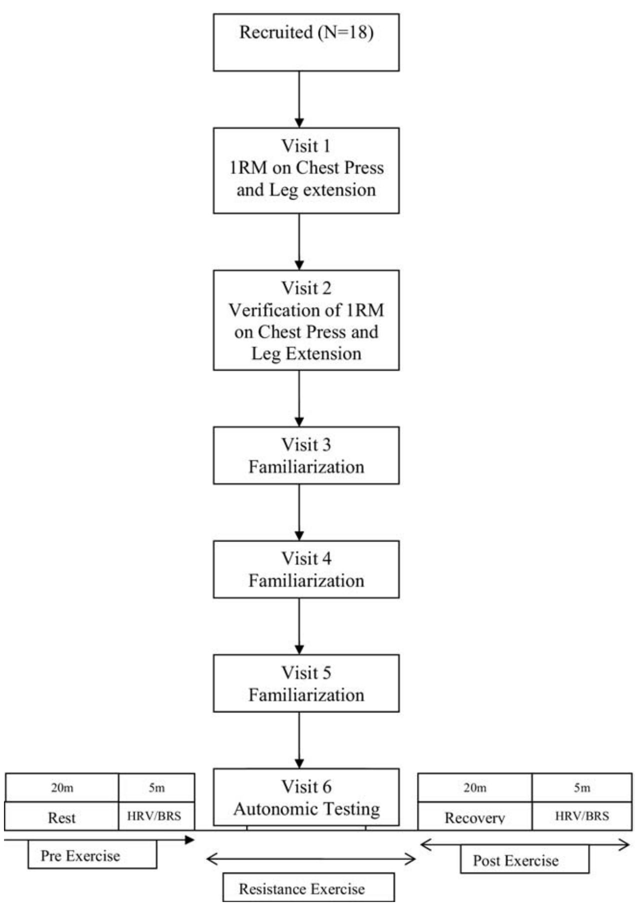

Fig 1. Flow chart for data collection and timeline for autonomic test.