Inspiratory Muscle Training Reduces Sympathetic Modulation in Elderly Patients with Insulin Resistance

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Studies have shown that physiological aging is accompanied by insulin resistance and reduction in heart rate variability (HRV) because of decreased vagal activity at the sinus node, decreased baroreflex activity, and increased sympathetic activity, resulting in reduced complexity of regulatory systems.[1]

The inspiratory muscle training reduces sympathetic activity, improves inspiratory muscle function, and increases the glucose transport within the musculature of the diaphragm.[2,3]

For this research, 21 insulin-resistant elderly patients were recruited on the basis of their results on testing with the homeostasis model assessment of insulin resistance. Variability in heart rate was evaluated while the patient was lying down resting for 10 min on a stretcher. The data were acquired using a Polar S810i® frequency meter (Polar Inc., Kempele, Finland).

The subjects were divided into two groups: a control group, which was trained using no Threshold® load, and an experimental group, which underwent respiratory muscle training using a Threshold load, with 40% of inspiratory pressure reached during the first session of each week. The program lasted 12 weeks, and both groups trained daily for 30 min.

Due to the small sample size, differences between the groups were tested using the Wilcoxon rank sum test.

A comparison of both the clinical and laboratory characteristics of the groups before and after treatment showed values of glucose, insulin, and homeostasis model assessment of insulin resistance changed. Respiratory exercise resulted in an increase in the standard deviation of NN intervals and in coefficient of variation in the experimental group. The absolute low-frequency (LF) component decreased in the experimental group. Further, the normalized LF component of HRV was lower in the experimental group. The normalized high-frequency component increased in the experimental group. Consequently, respiratory exercise promoted a decrease in sympathovagal balance in the experimental group. A positive correlation was found between insulin and sympathetic modulation (LF% $r = 0.34$, $p = .03$), and abdominal circumference showed a positive correlation with LF% ($r = 0.53$, $p = .006$; **Figure 1**).

The major finding of this study was that inspiratory muscle training increased HRV and decreased sympathetic modulation in elderly patients with insulin resistance, without changing the respiratory frequency, through strengthening of the inspiratory muscles.

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Abbreviations: (HRV) heart rate variability, (LF) low frequency

Keywords: aging, insulin resistance, heart rate variability, respiratory training aging, insulin resistance, heart rate variability, respiratory training

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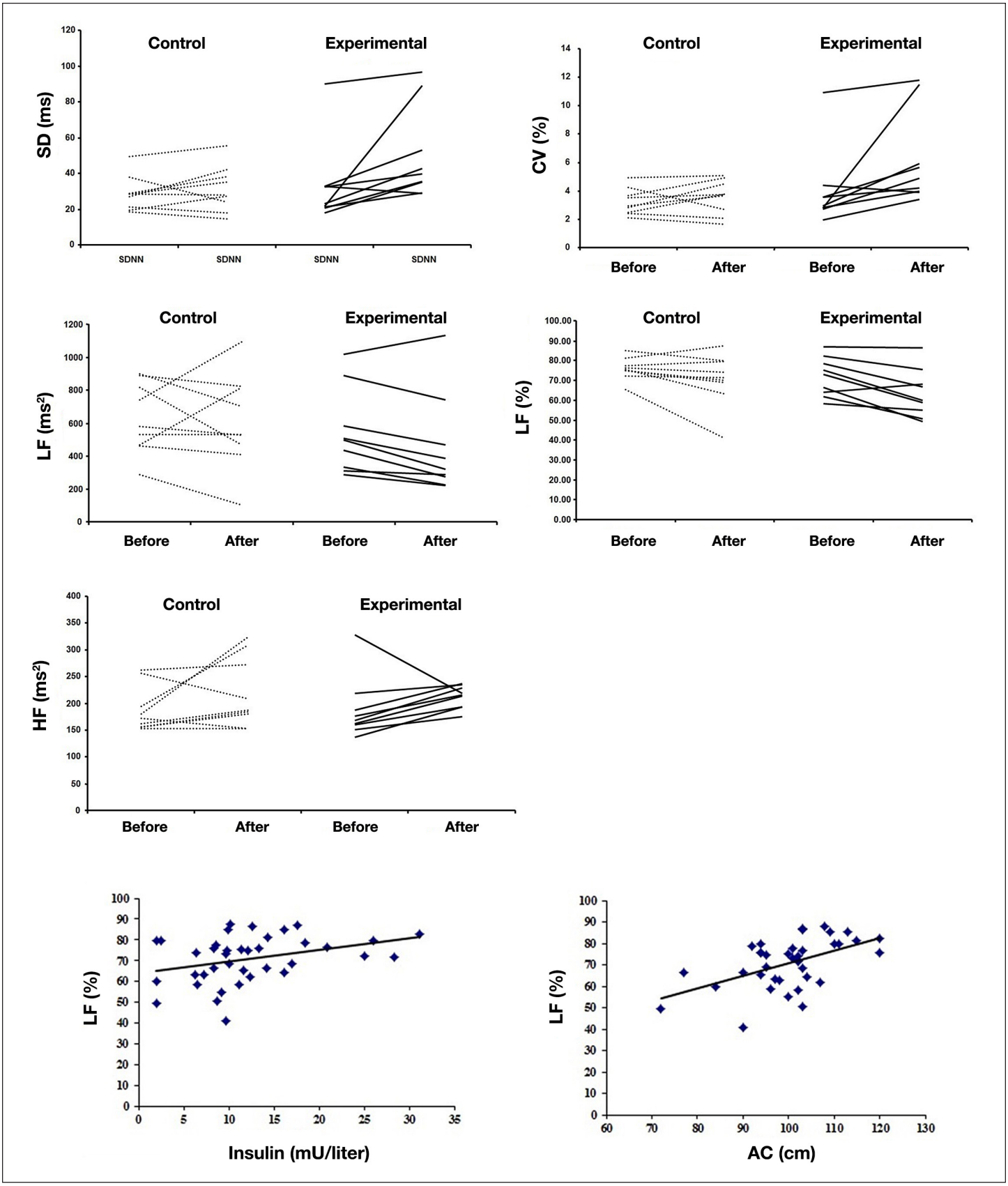

Figure 1. Sympathetic modulation and sympathovagal balance. SD, standard deviation; SDNN, standard deviation of NN intervals; CV, coefficient of variation; HF, high frequency; AC, autonomic control.

The current study identified a correlation between cardiac sympathetic modulation represented by the LF component, insulin levels, and waist circumference. Studies have demonstrated that decrease in HRV is associated with fasting glucose and insulin levels, and individuals with insulin resistance have a reduced parasympathetic component.[4]

In this study, we observed an increase in HRV subsequent to the trial intervention because of a small increase in the coefficient of variation of RR intervals and standard deviation of NN intervals index. However, the sympathetic and parasympathetic modulation represented by the absolute LF component was reduced. This suggests that breathing exercises enhanced autonomic function by decreasing the sympathetic activity without an increase in parasympathetic tone.

This study shows that inspiratory muscular training significantly improves HRV and insulin sensitivity, and it may be a promising noninvasive treatment for elderly who cannot engage in aerobic exercise.

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