EFFECT OF ISOMETRIC HANDGRIP EXERCISE TRAINING ON RESTING HEMODYNAMICS: A PILOT STUDY

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ABSTRACT

Objective: The purpose of the present study was to examine 1) whether Isometric Handgrip (IHG) training lowers arterial pressure at rest, and 2) whether possible reductions in arterial pressure are associated with reductions in the heart rate variability (HRV).

Methods: This case series consisted of 2 hypertensive female subjects who were trained with four 3-minute bouts of IHG exercise at 30% maximal voluntary contraction (MVC) separated by 5-minute rest periods. Training was performed 4 times per week for 4 weeks. Subjects' resting arterial pressure were measured before and after training each day for 4 consecutive days, with HRV recorded on the third day each week.

Results: In the first subject, resting diastolic pressure decreased from 120 to 90 mmHg and systolic arterial pressure decreased from 160 to 140 mmHg, whereas heart rate increased from 52 to 55 beats/min, and HRV did not change following training. The decrease in blood pressure was seen after 3 weeks of handgrip exercise. In the second subject, no trend of blood pressure reduction was seen but the systolic arterial pressure decreased before and after the handgrip exercise at 10 training days out of the 17 possible days. In the other 7 days, 6 days showed no blood pressure changes after handgrip exercise. The HRV in the LF, HF, VLF ranges did not change with training.

Discussion: Handgrip exercise moderately reduced blood pressure in the 2 female hypertensive subjects. The reduction of blood pressure and response to HRV seemed to relate to subject's history of using hypertensive medication.

Conclusion: IHG training might be an effective nonpharmacological intervention in lowering arterial pressure. Further study is needed. (*J Chiropr Med* 2003;27:153-156)

KEY INDEXING TERMS: Hypertension; Heart Rate Variability; Isometric Exercise

INTRODUCTION

Hypertension is a common clinical diagnosis defined as a diastolic blood pressure of 90 mmHg or higher or a systolic pressure of 140 mmHg or higher (1). It has been estimated that 43 million Americans suffer from hypertension and it is more common in older adults (1). Results from the Framingham Heart Study show that the benefit of reducing blood pressure by only a few mmHg, leads to significant reductions in the risk of coronary heart disease and stroke incidents (2).

Randomized, well-controlled exercise intervention studies have shown consistently that regular aerobic exercise significantly lowers blood pressure in patients with essential hypertension (3). Mild to moderate intensity exercise may be more effective in lowering blood pressure than higher intensity exercises. Such exercise is safe and effective in lowering blood pressure in treated patients with severe hypertension and left ventricular hypertrophy. A significant reduction in blood pressure and regression of left ventricular hypertrophy may be achieved in these patients even after substantial reductions in antihypertensive medication. Recent findings have also shown that exercise training attenuates exaggerated blood pressure response during physical exertion. The safety and efficacy of mild to moderate exercise has significant and positive clinical implications for all hypertensive patients. Exercise-induced reductions in resting blood pressure and prevention of abnormal increases in blood pressure during physical exertion can lead to fewer cardiovascular events. They may also reduce antihypertensive medication requirements, cost, and medication-related side effects, and improve quality of life.

Handgrip exercise is a simple form of exercise with relatively low risk to hypertensive patients (4). It has been used in patients with heart failure and hypertension (5-7). Handgrip exercise has been found in recent years to be beneficial in improving cerebral hemodynamic (8), forearm vascular response (9), and autonomic nervous system regulation on blood pressure (10,11).

This exploratory study was designed to determine the cumulative effects of weeks of isometric handgrip exer-

cise training on resting hemodynamic functions including heart rate, systolic and diastolic blood pressure, and heart rate variability indices of cardiac sympathetic and parasympathetic tone.

METHODS

Participants

Two female college faculty and staff members with mild hypertension were recruited in the pilot study. Medical histories including hypertensive medication was collected. Subjects signed consent form before participation of the study.

Inclusion Criteria

Diagnosis of mild hypertension, normal handgrip capability, no contraindications to brief (3-s) maximal isometric handgrip exercise testing or 3-min bouts of submaximal (30% MVC, or moderate-intensity) handgrip exercise and completion of an informed consent form.

Experimental Design

The single-subject (time series) experimental design was used with 2 subjects. Weekly assessments represented a 2-wk baseline (pre-intervention) phase and a 4-wk training phase. Subjects were asked to continue their daily antihypertensive medications at the same time of day during the study.

Outcome Measures

Before intervention, all resting hemodynamic outcome measures were assessed for 3 consecutive trials on 2 consecutive days. They included heart rate (HR), systolic and diastolic blood pressure (SBP and DBP), mean arterial pressure (MAP), and heart rate variability indices of cardiac sympathetic (SYMP) and parasympathetic tone (PARA).

The Biopac MP 100 was used to record ECG and the R-R intervals necessary for HR variability analysis and computation of the SYMP and PARA. Disposable electrodes (silver/silver chloride) were used for all bipolar ECG measurements. The positive electrode was placed on the left arm, the negative electrode was attached to the right arm and the ground electrode was placed on the right leg. MP 100 amplifiers (model MP100; Biopac Systems, Inc. Santa Barbara, California) were used for ECG amplification. All post-analysis, including Fast Fourier Transforms and power spectral density were performed with digital signal processing software. The blood pressure cuff/sensor of the Biopac system was

used to measure blood pressure at the left brachial artery.

Assessments

Assessment sessions for each subject throughout the study were scheduled at the same time of day to prevent diurnal and medication-induced variation in hemodynamics. Subjects were assessed weekly on the same day of the week. Subjects were asked to arrive at the Research Center without having eaten a large meal or exercised within 3 hours. Subjects were taking a sitting position with electrodes applied to the left arm, right leg and left leg, as necessary for the measurement techniques. The room was warm, quiet and dimmed for testing. Subjects rested for 15 minutes before data collection. R-R intervals were collected continuously for five minutes during the session.

Training

Each subject was asked to follow the procedure utilized by Wiley et al. (6) and Ray and Chester (7) with normotensive subjects. Subjects used a handgrip dynamometer to train with isometric handgrip exercise 4 sessions/week for 4 weeks. During each session, subjects performed four 3-min bouts of isometric handgrip exercise with the dominant hand at 30% of maximum voluntary contraction (MVC). Subjects took a sitting position during training with the working arm extended toward the front. Each bout was separated by a 5-min rest period. Before each training session, each subject's MVC value was determined as the highest value obtained on three 3-s attempts. They were continuing their normal daily physical activities during the training phase.

Data Analysis

No inferential statistical tests were used. Outcome measures were plotted against time to show changes in trends across time (i.e., among baseline, training and detraining phases). To help design future research studies, trial-to-trial and day-to-day reliability estimates were expressed as percentage changes among phases.

RESULTS

Case 1

The first case was a Caucasian 55-year old female who had a long history of hypertension but had never taking any hypertensive medication. She presented no physical difficulties except complained headaches 2–3 times a week and had to use medication to control the pain. The subject smoked 3–5 cigarette a day but reported no

history of drinking alcohol. Changes in blood pressure, pulse rate and HRV are shown in Table 1. The subject's blood pressure was significantly reduced at week 3 and 4. Blood pressure was not increased during exercise. The pulse rate was increased after the handgrip exercise (Table 1). There were no significant changes in HRV (Table 1).

Case 2

The second case was also a Caucasian female of 50-year old with more than 10 years history of hypertension. The subject was taking 1 hypertensive medication a day to control her blood pressure (Bisiprol 5 mg/day) and had maintained an active working schedule presented no symptoms of headache, palpitation, and dizziness. The subject reported no history of smoking cigarette and drinking alcohol. Changes in blood pressure, pulse rate and HRV are shown in Table 2. The subject's diastolic blood pressure did not show significant reduction during the 4-week handgrip exercise training. However, the systolic blood pressure decreased from 140 to 130 mmHg at the fourth week. Although a trend of blood pressure reduction was not observed, this subject responded to the handgrip exercise by reducing blood pressure immediately after the 4 bout of handgrip exercise in 10 out of a possible 17 training days. Among the other 7 days, 6 days showed no change in blood pressure and only 1 day showed an increase in blood pressure after the 4 bout of handgrip exercise. There were

no changes in pulse rate (Table 2). The HRV analysis showed a relatively low variability of the heart rate before and after the handgrip exercise. The blood pressure and pulse rate was recorded reliably over a 4-week period with less than 20% change each day.

DISCUSSION

This study demonstrated that handgrip exercise is moderately effective in reduction of hypertension after the exercise over a 4-week study period. This may be significant in transient or sustained reduction of blood pressure in subjects who have difficulty in ambulation-based exercise. This finding is consistent with reports that mild and moderate intensity exercise is beneficial to patients with hypertension (12–16). It was noticed that blood pressure in these 2 female subjects reduced immediately after handgrip exercise. The mechanism of blood pressure reduction is related to greater vasodilation caused by increased demand for blood flow and O₂ in tissue cells (17). It has been hypothesized that endothelin-1 (ET-1) is involved in blood pressure control and plays a pathophysiologic role in the development of clinical hypertension. Handgrip exercise in subjects with a family history of hypertension had higher baseline ET-1 levels that increased further at peak handgrip exercise (18). The response to handgrip produced increased ET-1 plasma levels and resulted in a sustained ET-1 release into the bloodstream during recovery compared with offspring of normotensive parents. It was

TABLE 1
HRV BEFORE AND AFTER HANDGRIP EXERCISE IN SUBJECT 1

	BASELINE		WEEK 1		WEEK 2		WEEK 3	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
HEART RATE	88.7	88.6	88.3	88.5	89.6	91.0	87.2	87.2
TOTAL POWER	438	414	782	752	672	531	331	831
HIGH F.	72	31	147	144	217	97	105	87
LOW F.	81	306	138	141	254	280	79	296
VERY LOW F.	284	77	496	466	200	153	146	447

F = FREQUENCY

TABLE 2
HRV BEFORE AND AFTER HANDGRIP EXERCISE IN SUBJECT 2

	BASELINE		WEEK 1		WEEK 2		WEEK 3	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
HEART RATE	50.7	52.2	58.0	58.9	68.4	71.9	61.5	72.3
TOTAL POWER	696	1875	2184	2467	1520	643	1876	1995
HIGH FREQ.	171	69	521	305	264	145	784	140
LOW FREQ.	311	390	1157	841	400	110	648	824
VERY LOW F.	212	1415	505	1320	855	387	443	1030

F = FREQUENCY

reported that long-term physical exercise improves endothelium-dependent vasorelaxation through an increase in the release of nitric oxide in normotensive as well as hypertensive subjects (19).

It was suspected that blood pressure would increase during the handgrip exercise in male subjects (6,7). To confirm this finding in female subjects, I repeated the handgrip study to test if blood pressure was indeed increased during the handgrip exercise. It was interesting that the female subjects did not show any significant increase in blood pressure during exercise. The blood pressure showed reduction before and after the handgrip exercise. This suggested that there might be a gender difference in blood pressure response to the handgrip exercise.

Patient history of using hypertensive medication might affect the outcome of the handgrip exercise. Although both subjects in the study presented long history of hypertension, subject 1 did not take medication for many years and subject 2 had been taking 1 hypertensive pill everyday for the past year including the study period. It was clearly indicated in Figure 1 that subject 1 had downtrend in both systolic and diastolic blood pressure as a result of the handgrip exercise. The downtrend of blood pressure was not seen in subject 2 who had been taking hypertensive medication. Despite the fact that subject 2 showed no clear trend in blood pressure reduction over time, there was short-term response of blood pressure reduction immediately after the handgrip exercise in 10 out of the 17 testing days. It is possible that this short-term blood pressure response is regulated by the autonomic nervous system activation through the handgrip exercise. Since the long-term blood pressure is regulated by the balance of fluid intake and output and it is strongly affected by the hypertensive medication (20), subject 2 was less sensitive to the regulatory effect of the 4-weeks of handgrip exercise on blood pressure.

There are many limitations of the single case study. We were unable to take continuous blood pressure during the training period. This additional information on blood pressure fluctuation could be useful to enhance our understanding of the hemodynamics of the handgrip exercise in blood pressure regulation. This study was also limited by the small sample size of two that made it difficult to draw any conclusions from the findings.

CONCLUSION

The handgrip exercise is moderately effective in reduction of blood pressure in the 2 female hypertensive

subjects. The effect was more noticeable in subject who had not been taking hypertensive medication. Heart rate and heart rate variability did not show significant changes over the 4-week handgrip training period.

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