Research Article

Can isotonic handgrip exercise cause postexercise hypotension in healthy adolescents?

Nileshkumar H Patel[1], Wasim Shaikh[2], Sushil Kumar Singh[2]

[1]Department of Physiology, GMERS Medical College, Himmatnagar, Gujarat. India.
[2]Department of Physiology, Pramukh Swami Medical College, Karamsad, Gujarat, India.
Correspondence to: Nileshkumar H Patel, E-mail: drnilesh80@gmail.com

Received July 3, 2015. Accepted July 13, 2015

Abstract

Background: A single bout of physical exercises involving large muscle mass such as brisk walking has been reported to produce postexercise hypotension for up to 12 h, which helps in managing high blood pressure (BP), prevents abrupt rise in BP, and acts as a routine day-to-day stressor along the day.

Objective: To determine the short-term effects of isotonic handgrip exercise on BP in healthy adolescents, as the compliance of people for routine form of exercise for BP control has not been very encouraging, with the objective to find a user-friendly exercise that helps in reducing BP.

Materials and Methods: We examined an acute bout of isotonic handgrip exercise for postexercise hypotension by a study conducted on adolescents aged 17–19 years ($N = 60$, boys and girls—30 each). The participants performed a single bout of isotonic handgrip exercise using ball-squeeze dynamometer at an intensity of 30% maximum voluntary contraction (MVC) for 20 min at the rate 12 contractions/min. The BP measurement was conducted before the bout of the exercise (baseline), immediately at the end of exercise (PE-I), and at 1 h in the postexercise period (PE-1 h).

Result: No significant difference was observed in the BP during PE-I and PE-1 h phases in both boys and girls.

Conclusion: It can, thus, be concluded that a single bout of isotonic handgrip exercise, as prescribed in the study, is not efficient to produce postexercise hypotension. However, before considering isotonic handgrip exercise to be inefficient, studies can be conducted on large population to reassess the isotonic handgrip exercise for postexercise hypotension by varying the intensity, rate, and duration of the exercise.

KEY WORDS: Isotonic handgrip exercise, blood pressure, postexercise hypotension, adolescents

Introduction

It is known that regular dynamic exercise reduces blood pressure (BP) and helps in the prevention of hypertension by various mechanisms such as decrease in sympathetic nerve traffic, potentiation of baroreceptor reflex, decrease in arterial stiffness, increase in total systemic arterial compliance, increase in the release of endothelium-derived nitric oxide, and increase in insulin sensitivity.[1] It has also been reported that an acute bout of dynamic physical exercise involving large muscle mass also results in lowering of BP lasting for 12–16 h in the postexercise period, known as postexercise hypotension (PEH).[2]

However, despite the strong evidences that recommend regular dynamic exercise involving large muscle mass (brisk walking and cycling) for lowering BP and prevention of hypertension, the compliance of people toward such forms of exercise has not been encouraging owing to various possible reasons such as comorbid conditions (osteoarthritis and coronary artery disease) and other constraints (such as time, space, and economic constraints).[3] It is, therefore, necessary to design an alternative feasible form of physical exercise

Access this article online	
Website: http://www.ijmsph.com	Quick Response Code:
DOI: 10.5455/ijmsph.2015.03072015323	

involving a relatively lesser muscle mass, which can reduce BP and increase exercise compliance in the population.

Isotonic handgrip exercise is a simple, cheap, and feasible form of physical exercise involving relatively lesser muscle mass, which can be performed as per individual convenience with respect to time and place using a simple equipment such as handgrip dynamometer. But, before we prescribe isotonic handgrip exercise to the population, it is essential to determine whether isotonic handgrip exercise decreases BP in postexercise period as an acute short-term effect (PEH) and/or over a long term as a training effect. It is also essential to understand the mechanism underlying such BP-lowering effects of isotonic handgrip exercise. As scant literature is available, which illustrate the role of isotonic handgrip exercise in lowering BP, we investigated a single bout of isotonic handgrip exercise for PEH.

Materials and Methods

This study was conducted after the approval of Human Research Ethics Committee and consent of the participants. The study was conducted on 60 college-going adolescents (boys and girls—30 each) in the age group of 17–19 years having a BMI in the range 15th–85th percentile. The study excluded participants who were smokers, athletes, and suffering from any chronic illness.

The body weight was recorded bare footed to the nearest 0.5 kg. The height was measured using meter scale without footwear to the nearest 0.5 cm. Body mass index (BMI) was calculated as the weight (kg) divided by the square of height (m^2).[4]

The selected study participants were asked to visit the Physiology Department at 5:30 p.m. on the exercise day. The preexercise baseline BP (PRE-B) was recorded; after performing a single bout of isotonic handgrip exercise, the immediate postexercise BP and the BP at 1 h into the postexercise period were measured.

Measurement of BP

The BP was measured in the left arm in the sitting position with arm and back support, uncrossed legs, and feet on the floor by oscillometry using the Omron T8 (HEM757A4-C1) automatic BP instrument. The BP was recorded at intervals of 1 min till the difference between the two consecutive BP readings was <5 mm Hg. The average of the two consecutive readings was used for statistical analysis. Pulse pressure (PP) and mean arterial pressure (MAP) were calculated from the average values of systolic blood pressure (SBP) and dias tolic blood pressure (DBP) using the standard formulas: PP = SBP – DBP and MAP = DBP + 1/3(PP).[4]

Method of Performing Single Bout of Isotonic Handgrip Exercise

The single bout of isotonic handgrip exercise was performed by the dominant hand of the participants using ball-squeeze dynamometer for a duration of 20 min continuously at an intensity of 30% maximum voluntary contraction (MVC). During the exercise, the participants were asked to squeeze the ball for 2 s (contraction phase) followed by release of the ball for 3 s (relaxation phase) such that a compression cycle rate of 12/min (each cycle had 2 s contraction followed by 3 s of relaxation) was achieved.[5] Exercise was stopped if the heart rate increased above 85% MHR or BP increased above 180/110 mm Hg.

Statistical Analysis

The mean and standard deviation of the study variables were calculated at PRE-B, immediate postexercise period (PE-I), and 1 h postexercise period (PE-1h). One-way ANOVA was used to study if any significant differences in study variables were observed between the preexercise and the postexercise periods. $P < 0.05$ was considered as significant.

Result

Table 1 shows the subject characteristics. As depicted in Tables 2 and 3, in comparison with the PRE-B condition, pulse rate, SBP, DBP, PP, and MAP were not found to be significantly different in the PE-I and PE-1 h conditions.

Discussion

This study indicates that isotonic handgrip exercise performed for 20 min at an intensity of 30% MVC at a compression cycle of 12 contractions/min cannot cause PEH in the postexercise period. Isolated aerobic exercise sessions produce immediate decrease in BP, which can persist for 12 h after exercise, especially in people with high preexercise BP.[2,6] But, the optimal exercise intensity needed to evoke PEH has not been established. PEH has been well documented in humans with both borderline hypertension and hypertension. However, its occurrence in normotensive humans is inconsistent, because of lesser magnitude than in hypertensive individuals and compensatory mechanisms such as the baroreflex, which are activated in normotensive people.[7] A direct comparison of the effect of exercise intensity has found that PEH occur as independent of exercise intensity. MacDonald et al.[7] found no difference in the magnitude of hypotension following 30 min of cycle ergometry at 50% and 75% VO_2 peak in normotensive volunteers. In contrast, Pescatello et al.[8] were unable to document PEH in a normotensive subjects. These findings show that the effect of dynamic exercise on BP in normotensive subjects is less clear. Our study was conducted on healthy, young, normotensive adolescents aged 17–19 years, and this could be the possible reason for no significant results after a single exercise session.

MacDonald et al.[9] also found that mass of the working muscle does not directly affect the magnitude of PEH but may influence the duration of the response in borderline

Table 1: Subject characteristics

Variable	Girls (30)	Boys (30)
Age (years)	17.9 ± 0.48	17.9 ± 0.66
Height (cm)	156.33 ± 7.22	170.5 ± 6.81
Weight (kg)	49.74 ± 7.78	62.18 ± 12.89*
BMI (kg/m^2)	20.37 ± 3.23	21.37 ± 4.17
Heart rate (beats/min)	85.25 ± 7.85	86.26 ± 13.74
SBP (mm Hg)	105.52 ± 6.85	113.53 ± 9.48
DBP (mm Hg)	69.4 ± 7.98	71.53 ± 8.01
PP (mm Hg)	36.1 ± 6.88	42 ± 8.01
MAP (mm Hg)	81.4 ± 6.9	85.53 ± 7.65

Values are given as mean ± SD.
*Significant difference between groups, $P < 0.05$.

Table 2: Short-term effects of single bout of isotonic handgrip exercise on blood pressure in girls

Variable	Baseline	PE-I	PE-1 h	*P*
Heart rate (beats/min)	85.25 ± 7.85	83.7 ± 9.075	83.73 ± 9.20	>0.05
SBP (mm Hg)	105.52 ± 6.85	106.13 ± 6.61	106.23 ± 5.04	>0.05
DBP (mm Hg)	69.4 ± 7.98	69.8 ± 7.39	69.93 ± 8.64	>0.05
PP (mm Hg)	36.1 ± 6.88	36 ± 7	36 ± 7.1	>0.05
MAP (mm Hg)	81.4 ± 6.9	82 ± 6.3	82 ± 6.87	>0.05

Values are given in mean ± SD.
PE-I, immediate postexercise period; PE-1 h, 1 h into postexercise period.

Table 3: Short-term effects of single bout of isotonic handgrip exercise on blood pressure in boys

Variable	Baseline	PE-I	PE-1 h	*P*
Heart rate (beats/min)	86.26 ± 13.74	86.43 ± 14.69	83.83 ± 11.44	>0.05
SBP (mm Hg)	113.53 ± 9.48	115.03 ± 10.68	114.23 ± 9.44	>0.05
DBP (mm Hg)	71.53 ± 8.01	74.3 ± 9.37	73.73 ± 8.52	>0.05
PP (mm Hg)	42 ± 8.01	40.73 ± 10.99	40.5 ± 7.84	>0.05
MAP (mm Hg)	85.53 ± 7.65	87.87 ± 8.35	87.23 ± 8.029	>0.05

Values are given in mean ± SD.
PE-I, immediate postexercise period; PE-1 h, 1 h into postexercise period.

hypertensive subjects. In contrast, Victor et al.[10] found no significant difference in MAP after rhythmic handgrip exercise at 10%, 30%, and 50% of MVC and mild two-arm cycling at 0 to 20 W; but, at 40- and 60-W intensity, two-arm cycling showed significant difference in arterial pressure response when compared with baseline values in the recovery period. This study showed no significant difference in BP after a single bout of 20-min isotonic handgrip exercise at 30% MVC.

Bennett et al.[11] have suggested that, in hypertensive subjects, the magnitude of the pressure decrement increases with an increased duration of exercise but could not substantiate this in a normotensive population. In contrast, MacDonald et al.[7] showed that SBP and DBP were unaffected by the duration of exercise and were lower than before the exercise at 30- through 45-min postexercise in both normotensive and borderline hypertensive subjects. Isotonic forearm exercise produces less of demand on heart than continuous isometric exercise. Greer et al.[12] found that cardiovascular response produced by isotonic exercises is intensity dependant and exercise sessions that includes relaxation between contractions shows lower cardiovascular response. Many studies done as rhythmic handgrip exercises show significant rise in muscle sympathetic nerve activity (MSNA) and BP during exercise sessions of different intensity but postexercise response is less significant.[5,10] In this study too, we have used almost similar protocol for isotonic handgrip exercise with more relaxation between contractions, which is probably responsible for the inability of the exercise to produce cardiovascular changes resulting in PEH.

A major limitation of the study was that the participants were all normotensive individuals and the sample size was less. Thus, it is essential to study the effect in prehypertensive and hypertensive population. It is also required to determine if PEH can be produced by changing the intensity, contraction cycle rate, and duration of exercise. Finally, it is essential to study the effects of isotonic handgrip exercise training on BP and cardiovascular autonomic functions on large population.

Conclusion

This study reveals that a single bout of an isotonic handgrip exercise performed by dominant hand at an intensity of 30% of MVC with contraction frequency of 12/min for 20 min does not lead to PEH for up to 1 h into the postexercise period. However, before discarding isotonic handgrip exercise for managing BP, further studies are required to determine if such exercise form can produce PEH in the hypertensive population and to study the long-term effects of training on BP with such form of exercise by increasing sample size.

References

1. Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, Eckler R, Fleq J, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation 2001;104(14):1694–740.
2. Thompson PD, Crouse SF, Goodpaster B, Kelley D, Moyna N, Pescatello L. The acute versus the chronic response to exercise. Med Sci Sports Exerc 2001;33(Suppl 6):S438–45.
3. Ghadzi SMS, Bahari MB. Pilot study on barriers influencing the compliance towards exercise recommendation in patients with diabetes mellitus. Int J Pharm Life Sci 2011;2(10):1107–14.
4. Shaikh WA, Patel M, Shah HD, Nimbalkar AS, Patel N, Singh SK. Arterial blood pressure is inversely associated with vascular sympathetic reactivity (isometric handgrip exercise) in Gujarati Indian adolescents. Indian J Physiol Pharmacol 2014;58(3):271–4.
5. Batman BA, Hardy JC, Leuenberger UA, Smith MB, Yang QX, Sinoway LI. Sympathetic nerve activity during prolonged rhythmic forearm exercise. J Appl Physiol 1994;76(3):1077–81.
6. Pescatelloa LS, Guidry MA, Blanchard BE, Kerr A, Taylor AL, Johnson AN, et al. Exercise intensity alters postexercise hypotension. J Hypertens 2004;22(10):1881–8.
7. MacDonald JR, MacDougall JD, CD Hogben CD. The effects of exercise duration on post-exercise hypotension. J Hum Hypertens 2000;14(2):125–9.
8. Pescatello LS, Fargo AE, Leach CN Jr, Scherzer HH. Short-term effect of dynamic exercise on arterial blood pressure. Circulation 1991;83(5):1557–61.
9. MacDonald JR, MacDougall JD, Hogben CD. The effects of exercising muscle mass on post exercise hypotension. J Hum Hypertens 2000;14(5):317–20.
10. Victor RG, Seals DR, Mark AL. Differential control of heart rate and sympathetic nerve activity during dynamic exercise. Insight from intraneural recordings in humans. J Clin Invest 1987;79(2):508–16.
11. Bennett T, Wilcox RG, MacDonald IA. Post-exercise reduction of blood pressure in hypertensive men is not due to acute impairment of baroreflex function. Clin Sci 1984;67(1):97–103.
12. Greer M, Dimick S, Burns S. Heart rate and blood pressure response to several methods of strength training. Phys Ther 1984;64(2):179–83.

How to cite this article: Patel NH, Shaikh W, Singh SK. Can isotonic handgrip exercise cause postexercise hypotension in healthy adolescents?. Int J Med Sci Public Health 2015; 4:1580-1583

Source of Support: Charutar Arogya Mandal, Karamsad, Gujarat, India. **Conflict of Interest:** None declared.