Section: Physiology

Original Research Article

AUTONOMIC RESPONSES DURING MAXIMAL VOLUNTARY CONTRACTION AND SUSTAINED VOLUNTARY CONTRACTION IN HEALTHY YOUNG ADULTS

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ABSTRACT

Autonomic cardiovascular testing assesses autonomic function using effector responses such as heart rate and blood pressure. The handgrip strength test is a quick, noninvasive, and inexpensive way to measure an individual's muscle strength. Response to maximal handgrip is a test for evaluation of Parasympathetic nervous system functioning showing change in heart rate. Sustained Isometric voluntary contraction is a test to evaluate the Sympathetic nervous system functioning that shows change in blood pressure. This study was carried out among 74 numbers of healthy young adults. The aim of the study was to determine how heart rate and blood pressure changes after maximal voluntary contraction and sustained voluntary contraction respectively.

INTRODUCTION

Autonomic nervous system maintains homeostasis through constantly active feedback loops. These feedback loops are in the form of reflexes that maintain basic visceral functions. The reflexes are elicited by visceral afferents that transmit subconscious stimuli. The two arms of the Autonomic nervous system-sympathetic and parasympathetic system act synergistically and reciprocally to regulate the visceral functions. In general increased sympathetic activity is seen during stress, physical activity, fear, excitement which may be regarded as "flight and fight" reactions. While increased parasympathetic activity is observed during vegetative behavior like staying sedentary or eating. Thus parasympathetic system is also called as "rest and digest" system.[1,2]

Autonomic cardiovascular testing assesses autonomic function using effector responses such as heart rate and blood pressure. In addition to providing an indication of the integrity of various autonomic cardiovascular reflex pathways, autonomic testing provides significant prognostic information in various cardiovascular diseases, neuropathies and neurodegenerative disorders.[3,4]

The handgrip strength test is a quick, noninvasive, and inexpensive way to measure an individual's muscle strength.[5,6,7] A great number of epidemiological studies supported the association of muscle fitness and functional decline in morbidity and mortality due to various diseases.[8-16] Handgrip strength represented the muscle strength of the forearm and upper limb when measured in a sitting position and also included lower limbs and core muscle strength when tested in a standing position.[8]

Various factors such as age, sex, and body composition influence handgrip muscle strength.**[17]**

Evidence is also available that regular resistance exercises also increase handgrip muscle strength.**[18]**

Previous studies confirmed that handgrip muscle strength is influenced by many physiological systems, so it can be used as biomarker for the diagnosis and prognosis prediction of various health problems. Researchers had found association of handgrip muscle strength with multiple chronic diseases and multimorbidity.[19]

Response to maximal handgrip is a test for evaluation of Parasympathetic nervous system functioning showing change in heart rate. Sustained Isometric voluntary contraction is a test to evaluate the Sympathetic nervous system functioning that shows change in blood pressure.

Many studies were there showing association of handgrip muscle strength with many physiological parameters, showing the link between muscle strength, endurance, and blood pressure in normal healthy young adults. Some studies showed negative,[20-22] some could not find any association,[23,24]and some showed positive [25] association of handgrip muscle strength with blood pressure. One study found showed association of handgrip muscle strength with blood pressure. They found that with increase in the skeletal muscle strength, there is increase in systolic blood pressure and decrease in diastolic blood pressure.[26]

Studies about how Maximal Voluntary Contraction and Sustained voluntary contraction affect the Sympathetic and Parasympathetic responses of healthy young adults are sparse in North-east India and Assam, so this study was undertaken to evaluate the effect of Maximal Voluntary Contraction MVC and Sustained Voluntary Contraction SVC on Sympathetic and Parasympathetic responses of healthy young adults with the following objectives.

Objectives:

1. To record the resting heart rate and resting blood pressure
2. To record the heart rate after maximal voluntary contraction post MVC HR & to record the blood pressure after sustained voluntary contraction post SVC BP
3. To evaluate how Maximal Voluntary Contraction MVC affect the heart rate of healthy young adults
4. To evaluate how the Sustained Voluntary Contraction SVC affect the blood pressure of healthy young adults.

MATERIALS AND METHODS

Study design: Cross sectional

Study duration: 6 months

Study setting: Department of Physiology, Jorhat Medical College & Hospital, Assam, India.

Study sample: Healthy young adults aged 18-24 yrs

Sample size: 74

Inclusion criteria

Healthy young adults both male & female aged 18-24 years consenting to the study

Exclusion criteria

Young adults with any disease and those who did not consent

Methodology

After getting IEC clearance, the study was initiated and all the subjects were detailed about the procedure properly. Written consent was taken from each participant.

Instruments required: Handgrip Spring Dynamometer (manual), Sphygmomanometer, and Stethoscope.

1. Response to maximal handgrip,[27,28] is a test for evaluation of Parasympathetic nervous system functioning. Basal HR is recorded. 10 sec rest is given to the subject. Subject is asked to contract the handgrip spring dynamometer maximally for 5 secs. HR is recorded after the maneuver.

Normal response is: Increase in HR

This initial rise in heart rate is due to vagal withdrawl.

2. Response to Sustained Isometric voluntary contraction,[29]is a test to evaluate the Sympathetic nervous system functioning. Baseline Heart rate and Blood pressure are recorded. Maximal Voluntary Contraction MVC is already known from test no 1. Subject is asked to sustain a contraction of 30% of maximum voluntary contraction (maximal hand grip strength) for 3 minutes using the hand dynamometer. Heart rate and Blood pressure are recorded before release of the handgrip.

SVC=30% of MVC sustained for 3 minutes

Normal response is: Increase in HR and Increase in Systolic and Diastolic BP

This late increase in heart rate is due to muscle metabo-reflex because of accumulation of metabolic end products-lactate, PG, H+, K+ and subsequent Sympathetic activation. Increase in Systolic blood pressure occurs due to increased cardiac output while increase in Diastolic BP occurs due to increase in peripheral resistance.

RESULTS

Statistically a p value<.05 is considered significant*
p value<.01 is highly significant**
p value<.001 is very highly significant***

Table1:Mean±SD of RHR(Resting Heart Rate) , change in HR postMVC (Maximal Voluntary Contraction)

Variable	Mean±SD	P value for t test	Pearson's correlation coefficient
RHR	77.18±6.60	.0004***	.3807
postMVC HR	76.73±7.02		

Table 2: Mean±SD of RSBP(Resting Systolic blood Pressure), Change in SBP postSVC(Sustained Voluntary Contraction)

Variable	Mean±SD	P value for t test	Pearson's correlation coefficient
RSBP	112.05±12.02	<.0001***	.6683
postMVC SBP	112.27±13.18		

Table 3: Mean±SD of RDBP(Resting Diastolic Blood Pressure), change in DBP postSVC(Sustained Voluntary Contraction)

Variable	Mean±SD	P value for t test	Pearson's correlation coefficient

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RDBP	71.92±9.96	.0006***	.3690
postSVC DBP	68±9.13		

DISCUSSION

The Mean±SD of resting heart rate was 77.18±6.60 and the Mean±SD of change in heart rate after Maximal voluntary contraction was 76.73±7.02. This change in heart rate on doing paired t test was found to be .0004 which is statistically extremely significant. Pearson's correlation coefficient was .3807 indicating extremely significant positive correlation.

The Mean±SD of resting systolic blood pressure was 112.05±12.02 and Mean±SD of systolic blood pressure after Sustained voluntary contraction was 112.27±13.18. this change in systolic blood pressure on doing paired t test was found to be <.0001 which is statistically extremely significant. Pearson's correlation coefficient was .6683 indicating extremely significant positive correlation.

The Mean±SD of resting diastolic blood pressure was 71.92±9.96 and The Mean±SD of diastolic blood pressure after Sustained voluntary contraction was 68±9.13. This change in diastolic blood pressure on paired t test was found to be .0006 which is statistically extremely significant. Pearson's correlation coefficient was .3690 indicating extremely significant positive correlation.

CONCLUSION

Our study found that after maximal voluntary contraction the resting heart rate changes, which statistically very highly significant and shows a positive correlation. After sustained voluntary contraction, which is the 30% of maximal voluntary contraction sustained for 3 minutes, there were changes in both systolic and diastolic blood pressure which were too statistically very highly significant and show a positive correlation.

Similar findings were reported by a study done at Johns Hopkins University,[30] which found SBP, DBP, PP and MABP all increased during sustained voluntary contraction for 2 min while heart rate increased initially and then leveled off. Another study found a positive correlation of handgrip muscle strength with systolic blood pressure while a negative correlation with diastolic blood pressure.[26]

Limitations

We took a smaller sample size for the study keeping in view the limited time period. We also did not try to find any difference between both the genders. A bigger sample size and variation of findings among different genders might provide scope for further study.

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