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Research Paper

Effect of Isometric Exercise on Cardiovascular Parameters of Young Adults

Medical Science

KEYWORDS :

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INTRODUCTION

Exercise plays a very important role in healthy life of an individual. However there are various stressors present in an individual's daily routine leading to a rise in morbidity and mortality .The most common cause of disease are cardiovascular problems .The cardiovascular problems are on a rise due to the increasing sedentary habits, bad diet management and stress full competition. Dynamic physical exercise (walking, swimming, jogging) is an important component of lifestyle changes to reduce blood pressure; however, many individuals are unwilling or unable to adopt this type of lifestyle, herein lies the role of isometric exercises. Isometric or static exercises are characterized by change in the muscle tension with no change in the muscle length whereas isotonic or dynamic exercises exhibit change in the muscle length with tension remaining the same[1]

Isometric exercises have been seen to play an important role in exercise rehabilitation and muscle strengthening specially in physiotherapy of weak muscles.[1] It has been reported to be effective in preventing a substantial loss of muscle mass and function during the period of recovery from an injury with joint immobilization(14,15).However it would be interesting to see the effect of isometric exercises on cardiovascular parameters as till now we have focused primarily on isotonic exercises as means for healthy living. Reduced resting blood pressure in response to isometric exercise training (IET) has been demonstrated in hypertensive patients& medicated hypertensive patients [2]

If some beneficial association can be seen between isometric exercise and cardiovascular parameters in normotensive individuals , it would provide new means of physical activity for individuals unable to perform hardcore isotonic exercises like old age, paralysis etc. Isometric exercises do effect CVS parameters**.** It would be interesting to see its effect on pulse rate, BP, ECG used in antihypertensive exercise regimen in future. (13) Few studies have also tried to find significant gender correlation between isometric exercises and CVS parameters but till now the results have been inconclusive[1].

However, extensive studies need to be conducted not only on hypertensive individuals but also on normotensive individuals to see the effect of isometric exercise on baseline BP and cardiovascular parameters. Hence this study hypothesizes that isometric exercise has beneficial effect on cardiovascular response in normotensive individuals.

Isometric exercise is responsible for increase in baseline values of BP & pulse in normotensive individuals when measured keeping the time of measurement constant with possibly some gender variation which may be due to hormonal effect as well as some positive correlation with BMI. Aim of this study was to determine the cardiovascular responses[BP, pulse rate, ECG] to upper extremity isometric exercises and difference between apparently healthy male and female subjects, and its correlation with Body Mass Index (BMI).

MATERIALS AND METHODS

Study Design: Cross sectional study.

Sample size: 100 ,by using appropriate statistical tools**.**

(Za)^2[p*q] where the symbol ^ means 'to the power of'; * means 'multiplied by'

N= d^2 that is, "Z-alpha squared into pq; upon d-square"

substituting the values of Za, we get:

$$N = \frac{(1.96)^2[p*q]}{d^2}$$

We can round off the value of Za (1.96) to 2, to obtain:

$$N = \frac{(2)^2[p*q]}{d^2}$$

or, $N = 4pq/d^2$ that is, "4 pq by d-square"

where-

p: The prevalence of the condition/ health state. If the prevalence is 32%, it may be either used as such (32%), or in its decimal form (0.32).

q: i. When p is in percentage terms: (100-p)

ii. When p is in decimal terms: (1-p)

d (or l): The precision of the estimate. This could either be the relative precision, or the absolute precision. This will be discussed later in this post.

Za [Z alpha]: The value of z from the probability tables. If the values are normally distributed, then 95% of the values will fall within 2 standard errors of the mean. The value of z corresponding to this is 1.96 (from the standard normal variate tables).

Subjects: 100 volunteers from medical students were enrolled for the study after taking their informed consent. Ethical clearance from the institute's ethical committee was taken before performing the study.

Inclusion criteria:

1] Subjects between 18-25yrs of age

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2] Subjects should be free from any known metabolic, cardiovascular, musculoskeletal disorders.

Exclusion criteria:
1] Below the age of 18yrs and above 25yrs

2] Subjects going to the gym regularly and on long term steroids or medications.

Method:
The baseline Blood Pressure , pulse rate and ECG of the participants were measured before starting the bilateral upper limb exercise on a handgrip dynamometer (Inco Ambala). Each participant was subjected to 3 rounds of upper limb isometric exercises for a period of 4 minutes with periods of rest of 5 seconds in between each round. In between, the subjects were instructed to avoid valsalva maneuver. The participants were asked to hold the dynamometer and press the bar using maximal effort for approximately. The maximum obtained by each participant was around 60mmHg**.** After completion of each round the variables measured were Pulse rate (beats/min) manually, Blood Pressure(mmHg) by sphygmomanometer ,Electrocardiogram by electrocardiograph. The blood pressure was measured in bilateral upper extremity simultaneously to rule out any difference in right and left hand BP, before starting and right after finishing each round, within 30 seconds. Then ECG was taken. Anthropometric measurements had already been taken while enrolling candidates, to calculate BMI.

Statistical analysis
Data was summarized as Mean ± SE. Groups were compared by paired t test and independent Student's t-test. Pearson correlation analysis was used to assess association between the variables BP, pulse, ECG and BMI. $p \leq 0.05$ was considered statistically significant. Graph Pad Prism (window version 3.0) was used for the analysis. For each outcome measures, a relative percent mean change (post to pre) was also evaluated as

$$\% \text{ change} = \frac{\text{Mean}_{post} - \text{Mean}_{pre}}{\text{Mean}_{pre}} \times 100$$

RESULTS
In the study, 35 males and 65 females were analyzed. The age group was between 18-21 years with average weight around 59.53 kgs, height around 162.67 cms and BMI around 22.26kg/m^2. [Table1]

Demographic characteristics
Table 1: Demographic characteristics (Mean ± SE, n=100)

Characteristics	Summary
Sex (M/F)	35/65
Age (yrs)	19.30 ± 0.25 (18-21)
Weight (kg)	59.53 ± 3.40 (42-96)
Height (cm)	162.67 ± 2.49 (140.2-181.0)
BMI (kg/m^2)	22.26 ± 0.83 (16.6-29.6)

Numbers in parenthesis represents the range (min-max)

Table 2: Pre and post exercise blood pressure and pulse rate (Mean ± SE, n=100)

Cardio-vascular parameters	Periods		% change	p value
	Pre exercise	Post exercise		
Pulse rate (beat/min)	87.75 ± 1.77 (68-100)	91.00 ± 2.43 (74-106)	+3.7%	0.1331
SBP (mmHg)	119.60 ± 2.38 (100-136)	118.80 ± 2.94 (98-142)	-0.7%	0.7420
DBP (mmHg)	77.80 ± 2.62 (68-110)	69.40 ± 2.58 (48-98)	-10.8%	0.0002*

Numbers in parenthesis represent the range (min-max)

+(ve): increase, -(ve): decrease, Student's Paired t- Test

Decrease in DBP was statistically significant

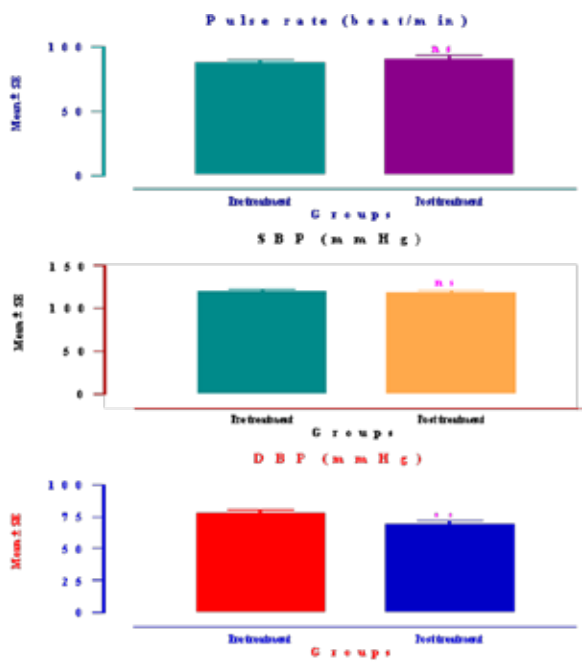

Fig. 1. Pre and post outcome measures of all studied subjects.

Fig. 1. Isometric exercise Blood pressure and heart rate[n=100]

Correlation- with BMI
Table 4: Correlation (n=100) of improvement in cardiovascular parameters with BMI

Variables	BMI	*Pulse rate*	*SBP*	*DBP*
BMI				
Pulse rate	0.29^{ns}			
SBP	-0.01^{ns}	-0.02^{ns}		
DBP	0.33^{ns}	-0.16^{ns}	0.35^{ns}	1.00

ns- p>0.05,[Pearsons correlation]
No significant correlation seen between individual parameters.

An increase from the baseline, in the systolic blood pressure and pulse with exercise was seen. However, this increase was not very significant [p> 0.05]. Unlike other studies conducted a decrease in the baseline diastolic blood pressure after performing the exercise (p value < 0.05) [Table2,Fig1] was seen. No difference was seen in pre and post exercise ECG tracings. No correlation was seen between the BMI and the measured cardiovascular parameters and like other studies no correlation could be established between gender and variation [Table4]

DISCUSSION

Exercise is a form of self induced stress leading to circulatory and respiratory adjustments in the body to the resultant increased metabolic demand. These changes depend upon the specific types of exercises undertaken, isometric or isotonic [1,3]. Isometric or static exercises are characterized by changes in the muscle tension with no change in the length whereas isotonic or dynamic exercises show changes in the muscle length with tension remaining the same. Most of the muscular activities are a combination of both isometric and isotonic contractions. The isometric contractions are seen in various exercises like pushing or lifting heavy loads, where net displacement of load is not present, but the rising tension can be felt in the contracting muscles. On the other hand, isotonic contractions are seen in the activities like running, cycling, swimming etc., where change of length can be appreciated but no change of muscle tension is appreciated. The isometric exercises involve small groups of skeletal muscles whereas in the isotonic exercises larger muscle groups are involved. Exercising muscles due to local metabolites released as well as sympathetic response receive increased blood supply after performing strenuous activity. However this response has been seen more in isotonic exercises as compared to isometric exercises. Few studies have shown that larger the muscle groups that are involved in isometric tension, greater the consequent cardiovascular responses to it [6,7] Therefore it can be said that while isotonic exercises lead to volume overload isometric exercises lead to pressure overload[8] It has also been seen in few studies that the diastolic blood pressure, in contrast to the isotonic exercises, decreases after isometric exercises due to accumulation of local metabolites and resultant vasodilatation [3].

Similar findings were reported in the present study. There was no significant difference in pulse rate and systolic blood pressure pre and post exercise. There was an increase in the pulse rate and SBP but this increase was not significant (p<0.05). However a significant difference was found in diastolic blood pressure between pre and post isometric exercise. The DBP decreased post exercise signifying a decrease in peripheral resistance in the post exercise period and period of recovery. This finding correlates with other studies which show that isometric exercise decreases resting blood pressure in hypertensive individuals [3, 9,10]. In another study it was seen that there was a difference in circulatory response to isometric exercises as compared to isotonic exercises [1] In isotonic exercise, the large muscle groups contract and relax rhythmically which allows adequate blood flow to the muscle with increased SBP while in isometric exercises, the small groups of muscles remain in the contracted state throughout the exercise resulting in the compression of the blood vessels and occlusion of blood flow to active muscle. Hence the findings here were that isometric exercise has been found to increase, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Heart Rate (HR) which are contrary to our findings. These findings were attributed to the fact that the static exercises obliterated the blood vessels in the active exercising muscle, raising the total peripheral resistance (TPR), thus increasing the pressure load or the afterload on the heart [2].

It has been seen that the isometric exercise with sustained handgrip provides a significant stress to the left ventricle [11]. The exact mechanism of the response of cardiovascular parameters to isometric exercise is not well understood. A reflex increase in cardiac output is apparently the first mechanism used to increase arterial pressure. In patients with a reduction in the ventricular reserve a further increase in the vascular tone has been seen to raise arterial pressure. However in the present study a decrease in the DBP was recorded . However theories relating to release of inhibitory neurotransmitters at the medullary centres which depress the VMC located in the medulla responsible for pressor tone of the vessels have been hypothesized [12]. As seen in a study this could also be a result of the study being performed on healthy normotensive individuals unlike most of the previous studies which have been performed on diagnosed heart cases or hypertensive individuals again seen in a study done by [13,14].Another theory being hypothesized for the same is local muscular vasodilatation in sustained hand grip [15], however this cannot explain the systemic decrease in DBP. However in few other recent studies conducted on normotensive individuals an increase in HR, SBP and Resting pulse pressure[RPP] was seen after exercise. While DBP and MAP have shown decreased values post exercise ,validating findings of this study despite our sample size being a limitation.[3] The DBP was not significant in either of the groups immediately after exercise cessation but DBP continued to fall and this fall became significant (p<0.05) during the recovery period at 1 minute after cessation of the exercise.[3]

In this study gender difference was also investigated but no significant difference in pulse, SBP and DBP was found. However recent studies have shown a greater increase in SBP in males as compared to females and greater fall in DBP in females [3]. This has been attributed to concentration of catecholamines and testosterones being more in males than females [3]. No significant correlation of BMI with pulse, SBP and DBP or ECG findings was found which may be due to BMI being within normal range. However few studies have shown that there is a positive correlation between BMI and DBP in females and males showed positive correlation between DBP, MAP and BMI [4]. No significant changes were seen in pre and post exercise ECG tracings.

The findings indicate a trend in the various parameters , however a larger sample size is required to come to a definite conclusion. The finding of a decrease in peripheral resistance leading to decreased DBP can help in isometric exercises being used as adjunct therapy to normal treatment protocol in hypertensive patients. Also its use in preeclampsia to decrease maternal and fetal morbidity and mortality can be considered. Like lifestyle modification and aerobic exercise module, isometric does not have any financial implication and is cost effective.

This is an attempt to define a trend in normotensive individuals who are performing isometric exercises and if we get a beneficial significant finding here, like decreased DBP, then to follow it up further on larger sample size with more controlled environment and then to try it on a hypertensive population to see the results. This study is limited by the very small sample size of the patients however more follow up work needs to be done taking into account diurnal variations and positional variations in Blood pressure.

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However if the hypothesis holds true in larger population and study group this could become a non pharmaceutical modality to treat high blood pressure due to high vascular resistance.

CONCLUSION

In the present study it was found that although post exercise there was increase in the individual values in SBP and pulse rate but this increase was not very statistically significant. Neither was there any positive correlation between BMI and the measured variables or any gender variation. No changes were seen in pre and post exercise ECG tracings. However a significant decrease was seen in the diastolic blood pressure post exercise indicating effect of isometric exercise in lowering peripheral resistance and hence DBP. This property if studied in greater detail can play an important role in non pharmacological management of hypertension. However due to limited resources and small sample size we need more extensive studies on this topic. Also role of diurnal variations on the CVS parameters was not taken into account which is a limiting factor for this study. However this study is an attempt to elucidate some initial correlation between isometric exercise and CVS parameters in which it was successful to some extent.

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CONFLICT OF INTEREST

None

Cardiovascular problems are the most common cause of disease these days. Various stressors in individual's routine lead to morbidity and can be reduced by exercise. Effects of dynamic exercise have been studied in detail. However, Isometric exercise needs to be studied in detail.

The effect of isometric exercise on cardiovascular parameters in normotensive adults was studied. Subjects were classified according to gender and BMI. Ethical clearance was taken from the committee. Subject's age ranged from 18-25 years. Consent was taken. Pre exercise pulse rate, Blood pressure and ECG were measured using sphygmomanometer and electrocardiograph respectively. The subjects were made to perform isometric exercise using Handgrip dynamometer at individual's performed maximum voluntary contractions possible.3 rounds performed with 5 seconds rest in between each round for total 4 minutes. Post exercise parameters were assessed. Statistically significant decrease in DBP [$p<0.05$, Paired student's t test] was seen post exercise. No statistically significant change seen in other parameters [PR, SBP, ECG]. No correlation was seen between any parameter and BMI. No gender variation was found.

Conclusion

Isometric exercise lowers peripheral resistance and DBP and thus can play an important role in non pharmacological management of hypertensio

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