Original article

Effect of blowing balloon exercise on modulating perceived stress, pulmonary function tests, ventricular depolarization and repolarization

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ABSTRACT

Background: Stress affects various physiological processes of the body. It induces cardiac changes through sympatho-vagal imbalance. Among the various remedies for stress, studies have proven the effectiveness of breathing exercises like yoga and jogging, but the effect of blowing balloon (another form of breathing exercise) on alleviating stress has not been studied yet.

Objective: The objective of current study was to determine the effect of blowing balloons exercise in improving pulmonary function tests and reducing stress-induced cardiac changes.

Materials and methods: This quasi-experimental study was conducted at Department of Physiology, Islamic International Medical College, Rawalpindi from 1st Feb 2016 to 31st Jan 2017. Sixty diagnosed students of moderate stress were included in the study after fulfilling the 14-item DASS (depression anxiety stress scale) Proforma. Pulmonary function tests, electrocardiogram (ECG) and DASS score of the participants was measured before and after a supervised blowing balloon exercise. Ten minutes ECG of the participants was recorded and the data were analyzed for measuring QTc interval and T peak to T end interval. These parameters were recorded by using Power lab model yam 4/25T and the data were analyzed by using software, lab chart 8 pro.

Results: Blowing balloon exercise resulted in significant reduction of DASS score of the study participants ($p<0.001$). Tidal volume, vital capacity, forced vital capacity, forced expiratory volume in one second and the ratio of forced expiratory volume in one second to the forced vital capacity were significantly improved ($p<0.001$) after blowing balloon exercise. The QTc interval of the participants were significantly reduced ($p<0.05$) after blowing balloon exercise.

Conclusion: Blowing balloon exercise is an effective way of improving pulmonary function tests and reducing stress.

Keywords:

Stress, depression anxiety stress scale, electrocardiogram, pulmonary function tests, power lab, lab chart.

INTRODUCTION

Reduction of one's abilities to manage the challenges of life, results in some psychological and physiological responses known as stress. Stress is a huge problem in today's society which has profound effects on performance of a person.[1] It has been reported to affect psychological wellbeing of students, which has become a cause of increasing concern worldwide.[2] A study on first year students of a public sector medical college in Lahore showed 7.5% of these students had low stress level, 71.7% had moderate stress level and 20.8% had high level of stress.[2] Stress has a psychological origin, yet it affects several physiological processes in the human body including disturbance of autonomic nervous system. It results in an increase in sympathetic discharge and a decrease in parasympathetic discharge. This sympatho-vagal imbalance is associated with various cardiovascular responses.[3]

Studies have shown that in the absence of ischemia, stress induced increased inhomogeneity of ventricular repolarization is associated with ventricular arrhythmias.[4] Parasympathetic and sympathetic nervous system acts in a reciprocal fashion. Stress upsurges the cardiac sympathetic fiber's activity and reduces the cardiac vagal fiber's activity. Decreased cardiac vagal tone is a prognostic marker for various cardiovascular diseases for instance myocardial infarction, coronary heart disease and congestive heart failure.[5] Vagal nerve activity is considered to affect social competence and stress resilience.[6] An individual's capability to cope with stress is known as resilience. Stress resilience levels fluctuate within a person and from person to person because of the variation in the basal level of an individual's vagal tone. Individuals with enhanced resting cardiac vagal tone are considered as more

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resilient and they exhibit speedy recovery towards basal cardiac functioning after a stressful event.[6]

Various strategies can be used in order to enhance stress resilience levels of an individual which includes group discussions, counseling sessions and physical exercises including cycling, jogging and running.[7,8] Studies have shown that breathing exercises reduce the influence of stress on the body and enhance the mental and physical health. Breathing exercises improve respiratory and cardiovascular functions of the body by enhancing parasympathetic tone and reducing sympathetic tone. The goal of breathing exercises is to improve the respiratory efficiency and relax quickly. Several studies have been conducted to prove the role of breathing exercises in the improvement of pulmonary function tests in healthy individuals.[9,10] Blowing balloon exercise is among one of the breathing exercises and has been used in reducing perceived level of stress, in rehabilitation of stroke patients, in treating obstructive sleep apnea syndrome, in oral gymnastics and in improving pulmonary function tests in smokers.[11-13]. Blowing balloon, exercises the respiratory muscles and results in an increase in tidal volume, vital capacity, forced vital capacity and compliance of the lungs.[14] Blowing balloon exercise works by increasing the depth of respiration. Review of literature shows that sympathetic nerve discharge in a conscious, resting individual can be modulated by various breathing parameters like beginning lung volume, tidal volume and breathing pattern. Elevated beginning lung volume, deep and low-frequency breathing enhances the cardiac vagal nerve activity by increasing the discharge of excitatory signals from slowly adapting pulmonary stretch receptors (SARs). These receptors are located within the airway and bronchial smooth muscle layer and correspond to the myelinated afferent nerve fibers which innervates the preganglionic cardiac vagal neurons.

The objective of this study was to assess the effectiveness of blowing balloon exercise in improving pulmonary function tests and alleviating stress induced cardiac changes by measuring ventricular depolarization and repolarization indices among medical students suffering from stress.

SUBJECTS AND METHODS

This quasi-experimental study was conducted in power lab room/ physiology lab, Department of Physiology, Islamic International Medical College, Rawalpindi after getting approval from institutional ethical review committee. A 14 item DASS (depression anxiety stress scale) questionnaire was distributed among 200 medical students in first and second years of Islamic International Medical College. Students who were of age 18-25 years and scored 19-25 on DASS proforma were included in the study. Students who were using any stress coping strategies, having oral lesions or using bronchodilator were excluded from the study.

Out of 200 students, 86 students were found eligible for the study. Among the eligible students, sixty participants were included in the study through simple random sampling by balloting method. After getting a written informed consent from the study participants, the pulmonary function tests of the participants was performed using power lab model yam 4/25T. Electrocardiography of the participants was recorded and analyzed by using power lab model yam 4/25T. Time taken by the heart to depolarize and repolarize was measured on electrocardiography (ECG) by calculating QT interval. The QT interval is principally influenced by heart rate (RR, cycle length), so in the analysis of QT duration, heart rate correction is required in terms of QTc. Stress results in prolongation of QTc interval due to non-uniform recovery of excited myocardial cells.[15] Ventricular repolarization alone was measured by analyzing the interval from peak of the T wave to the end of the T wave i.e. T peak to T end interval, (TpTe).[16] Study participants were then subjected to supervised blowing balloon exercise for three days in a week for six consecutive weeks. Participants performed three sets of blowing balloon exercise in a day.[11,17] During each set participants were requested to obtain an upright position. They were instructed to maximum breathe in, then maximum breathe out in a commercially average medium-sized balloon mouth. Participants were then again asked to maximum breathe in and then breathe out maximum in balloon mouth. This completed one mini set of blowing balloon exercise. Repetition of mini sets by three times, completes one set. All participants used the same type and size of balloons. To prevent fatigue participants were provided with a 2 to 3 minutes break between consecutive sets. Participants were counseled to discontinue exercise whenever they sense dizziness. In order to prevent Valsalva, participants were counseled to not hold their breath for more than five seconds after they breath out. After completion of blowing balloon exercise six weeks pulmonary function tests and electrocardiography of the participants were again recorded by using power lab model yam 4/25T. Statistical analysis of the data was done by using Statistical Package for Social Sciences version 21 (SPSS 21). Results from quantitative data were documented as mean $\pm$ SD. Paired t-test was used for the comparison of data before and after the blowing balloon exercise. A p-value of ≤ 0.05 was considered as statistically significant.

RESULTS

DASS proforma was initially distributed 200 students out of which 183 students returned the proforma (response rate 91.5%). Eighty-six out of these students fulfilled the selection criteria and sixty students were selected through simple random sampling by balloting method. DASS score, indices of pulmonary function tests and electrocardiography of the participants were measured before and after blowing balloon exercise. All participants

completed all the sessions of blowing balloon exercise and there was no drop out, so the compliance rate was 100%.

DASS score of the study participants is displayed in Table 1. The DASS score (21.87 ± 2.01) of the participants was significantly reduced to (13.41 ± 4.29) after blowing balloon exercise for six weeks ($p<0.05$). Table 1 shows the pulmonary function test indices of study participants. All The indices of pulmonary function tests were significantly improved after accomplishment of blowing balloon exercise. Among the indices of ventricular depolarization and repolarization QTc interval (422.50 ± 35.51 msec) of the participants was significantly reduced ($p<0.05$) to (384.86 ± 26.01 msec) after blowing balloon exercise for six weeks. Whereas T peak to Tend interval (77.21 ± 9.82 msec) of the participants was slightly decreased ($p>0.05$) to (74.75 ± 9.46 msec) and no significant change was observed after blowing balloon exercise for six weeks as shown in Table 1.

DISCUSSION

Higher prevalence of stress in medical students is a huge problem worldwide.[2] It disrupts normal physiological and psychological functioning of the body. The findings of present study revealed that blowing balloons therapy for six weeks lead to significant improvement in pulmonary function tests as well as a significant decrease in DASS score of the study participants. Moreover blowing balloons also significantly reduces the ventricular depolarization as indicated by QTc interval.

Kjellgren and colleagues[17]reported that yogic training exercise for a period of three hours in a day, for six days in a week, for seven weeks lead to a decrease in stress, anxiety and depression levels of the students. DASS score of the current study participants was also significantly decreased as a result of blowing balloon exercise. However, the compliance rate of current intervention was 100% in comparison with that of yogic exercise which was of 94.17%.[17] Moreover exercise performed by these study participants was of shorter duration; ten minutes in a day, three days in a week, for six consecutive weeks.

Physical activity which includes any type of exercise is correlated with the regulation of pulmonary functions of the body. Vancampfort and coworkers[18] concluded that exercise performance by an individual improves his pulmonary function tests. Present study shows that practice of blowing balloon exercise for six weeks results in significant improvement in indices of pulmonary function tests (TV, VC, FVC, FEV1 and FEV1/FVC).

Blowing balloon exercise results in forceful expiration which strengthens the expiratory muscles of the body (rectus abdominis, transversus abdominis and internal intercostal). Expiratory muscle training reduces the airway resistance and improves respiratory capacity. Deep inspiration before blowing balloon, fills air passage and improves lung volumes. Findings of this study is also in line with the study conducted by Renuka and coauthors[19] who reported that blowing balloon exercise resulted in an increase in total lung capacity when performed by chronic lung disease patients. In contrast to patients, present study was performed on healthy individuals.

Blessy and group[20] concluded that performance of Bhastrika pranayama yogic exercise, another form of breathing exercise, for a period of five times a day for three months lead to enhancement of TV, FVC, FEV1/FVC in healthy subjects ($p<0.02$). Participants of their study performed forceful exhalation after deep and slow nasal inhalation. This is in line with the findings of present study in which pulmonary function tests of the participants is significantly improved ($p<0.000$), however exhalation of this study participants was done against resistance which could explain the obvious enhancement of pulmonary function tests as compared to the enhancement in pulmonary function tests due to Bhastrika pranayama exercise used by Blessy and group in which simple forceful exhalation was done.

Table 1. Comparison of participant's DASS score, pulmonary function test, ventricular depolarization and repolarization before and after blowing balloon exercise

Variable	Balloon blowing exercise [Mean ± SD]		p-value*
	Before exercise	After exercise	
DASS score	21.87 ± 2.01	13.41 ± 4.29	<0.001
Pulmonary function tests			
Tidal volume (milliliters)	517.72 ± 48.57	638.65 ± 86.02	<0.001
Vital capacity (liters)	3.51 ± 0.56	4.83 ± 0.77	<0.001
Forced vital capacity (liters)	3.09 ± 0.57	4.45 ± 0.78	<0.001
Forced expiratory volume in one second (liters)	2.76 ± 0.54	4.13 ± 0.77	<0.001
Forced expiratory volume in one second/forced vital capacity (%)	89.36 ± 4.54	92.66 ± 4.27	<0.001
Ventricular depolarization and repolarization			
QTc Interval (msec)	422.50 ± 35.51	384.86 ± 26.01	<0.001
T peak to T end Interval (msec)	77.21 ± 9.82	74.75 ± 9.46	0.212

*p-value≤0.05 was taken as significant

Increased sympathetic or decreased vagal nerve activity is linked with non-homogenous shortening of action potential, resulting in prolongation of ventricular depolarization and repolarization which is a risk factor for generation of life-threatening rhythm disturbances.[21] James and colleagues[22] demonstrated that acute psychological stress resulted in prolongation of QTc interval and is a risk factor for ventricular arrhythmias. Physical activity,

exercise or relaxation strategies can reduce the effect of stress by correcting autonomic imbalance and increasing parasympathetic tone.[23]

Genovesi and coworkers[4] reported that physical exercise (sports activities) resulted in a significant reduction in heart rate and QTc interval of ECG. This is in line with the findings of current study as blowing balloon exercise also resulted in significant reduction in heart rate and QTc interval.

Blowing balloon exercise resulted in a significant reduction of QTc, which is a marker of ventricular repolarization but no significant change was observed in T peak to T end interval. Present study is in line with the finding of study carried out by Roche and associates[24] which concluded that stress induced prolongation of QTc interval is not associated with prolongation of T peak to T end interval. It may be possible that ratio of T peak to T end interval to QTc interval gives a different result as demonstrated by Gupta, P and colleagues which concluded that ratio of T peak to T end interval to QTc interval is a better measure for evaluating ventricular repolarization and can be used as an index of arrhythmogenesis.[25]

CONCLUSION

Blowing balloon exercise may be used as one of the stress reducing strategy. It improves the pulmonary function tests and enhances the parasympathetic tone as indicated by indices of ventricular depolarization. However, more studies are needed to find its usefulness in various age groups and with existing comorbidities.

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