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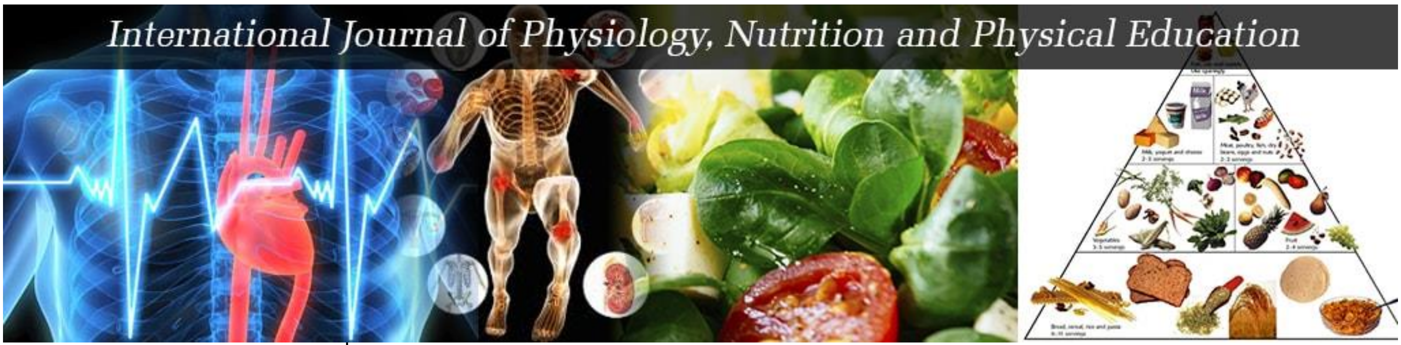

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Tension time index in athletes and non-athletes

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Abstract
The present study was done to compare tension time index in athletes and non-athletes. Improvement to maximal oxygen uptake is mainly due to myocardial adaptations brought about by physical training. As a consequence, the athlete's heart echocardiographic modifications associated with these adaptations are already well-known. Student of cardiac physiology have recognized since 1940 importance of tension time and left ventricular ejection time as two main parameters of cardiac function.
After getting approval from medical ethics committee at Dr. D.Y. Patil Hospital & Research center, Nerul, Navi Mumbai, 20 athletes and 20 non-athletes (age-group above 18 - 24 years) were asked to do treadmill at different duration by using Bruce protocol after signing informed consent form for 3 times a week by keeping some criteria and their systolic time intervals .i.e. pre-ejection phase (PEP), Left ventricular ejection time (LEFT), duration of systole. i.e. total electromechanical systoles (QS2) were measured through 3D echocardiography.
There tension time index was calculated. After doing statistical analysis, it was found that tension time index, which is a measure of myocardial activity, is increased in athletes than in non-athletes. (p<0.01).

Keywords: Tension time index, athletes, non-athletes

Introduction

Student of cardiac physiology have recognized since 1940 importance of tension time and left ventricular ejection time as two main parameters of cardiac function. One of the important technique to assess left ventricular performance is systolic time intervals to but most frequently used index of left ventricular function is left ventricular ejection fraction. The time integral of ventricular pressure during systole (Tension time index) has a much better correlation with myocardial oxygen consumption per beat than stroke volume, peak systolic pressure. This relation is an important guide to oxygen requirement of heart per beat.
Improvement to maximal oxygen uptake is mainly due to myocardial adaptations brought about by physical training. As a consequence, the athlete's heart echocardiographic modifications associated with these adaptations are already well-known. The increased stroke volume that is a salient effect of training in normal subjects can be achieved simply by increasing cardiac dimensions or by improving the performance characteristics of the heart. Pump performance may be increased by (a) enhancing the intrinsic contractile properties of the myocardium and the responses to inotropic stimulation and (b) extramyocardial adaptations that have secondary effects on performance--e.g, by increasing ventricular filling or decreasing myocardial work.

Methodology

Sample collection: After getting approval from medical ethics committee, this study was done in Stress Test Lab at Dr. D.Y. Patil Hospital & Research center, Nerul, Navi Mumbai. For this study, 20 athletes and 20 non-athletes (age-group above 18 - 24 years) were asked to do treadmill at different duration by using Bruce protocol after signing informed consent form for 3 times a week. (till to get 90% of maximal, age-predicted heart-rate).
Treadmill – intensity – 10mm/mv, frequency – 50 hertz, speed – 25 m/sec.

Inclusive criteria: Inclusive criteria was BMI should be 18–24.6m2/kg (according to National Institute of Health Science)

Exclusive criteria: Exclusive criteria was– 1. Subject should have a 2-3 hours gap between diet and exercise, 2. Subject should not have cardio respiratory or orthopedic disease.
Safety parameters chosen were age, height, weight, blood pressure, pulse, systolic time intervals (pre-ejection phase, Left ventricular ejection phase, duration of systole. i.e. total electromechanical systole) derived from Echocardiography and tension time index was predicted.

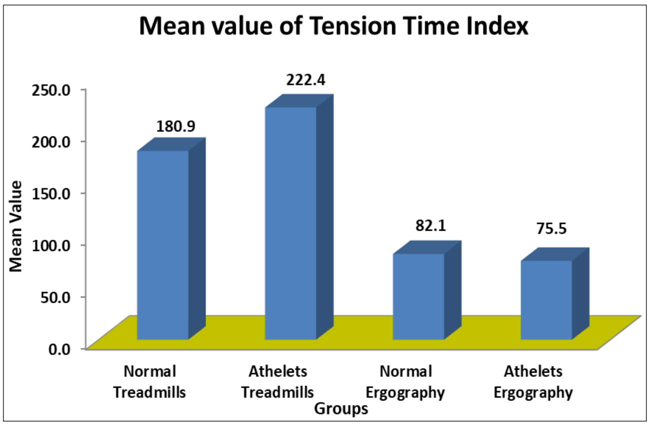
Systolic time intervals: Systolic time intervals .i.e. pre-ejection phase (PEP), Left ventricular ejection time (LEFT), duration of systole. i.e. total electromechanical systoles (QS2) were measured through 3D echocardiography.

3DEchocardiophy: 3D echocardiography is done by Doppler's method, which is a standard method to record systolic time intervals, transducer used is of frequency 21HZ, velocity – 2 to 2.5 megavolt.

Measurement of systolic time intervals
Duration of systole (QS2) = Pre-ejection phase (PEP) + Left ventricular ejection time (LVET)
Pre-ejection phase (PEP) = represent time for electrical as well as mechanical events that precede systolic ejection, is due to transmission delay. Normal range for pre-ejection phase -129 msec,
Duration of systole (QS2) = Period between onset of Q-wave to closure of aortic valves as determined by onset of second heart sound. Normal range for Duration of systole – 539 msec.
Left ventricular ejection time (LVET) = Period from beginning of carotid pressure rise to the dicrotic notch, a small oscillation on the falling phase caused by vibrations set up when the aortic valve snaps shut. Normal range for LVET-410 msec
Calculation of Tension Time Index
Tension Time index = systolic pressure x duration of systole x pulse
While calculating Tension time index, duration of systole which is in msec. is converted into minute- minutes = milliseconds ÷ 60,000

Parameters	Treadmills	N	Mean	Stdev	Unpaired T Test	P-value	Significant at 5% level
Duration	Normal Treadmills	14	11.8329	1.2216	2.052*	0.048	Yes
	Athelets Treadmills	21	12.6352	1.0720			
Sys.time interval							
VO2max	Normal Treadmills	14	46.6314	4.2500	2.168*	0.037	Yes
	Athelets Treadmills	21	49.6471	3.8824			
PEP	Normal Treadmills	14	65.5714	4.2193	0.750	0.458	No
	Athelets Treadmills	21	64.2857	5.3958			
LVEP	Normal Treadmills	14	288.1429	21.4758	5.992**	<0.001	Yes
	Athelets Treadmills	21	356.2857	38.6357			
Duration of systole	Normal Treadmills	14	350.0714	23.2857	5.787**	<0.001	Yes
	Athelets Treadmills	21	411.6190	34.8590			
Ejection Fraction	Normal Treadmills	14	5.7921	1.0628	2.380*	0.023	Yes
	Athelets Treadmills	21	6.6129	.9559			
Recovery time	Normal Treadmills	14	3.7736	1.2701	1.850	0.073	No
	Athelets Treadmills	21	3.2476	.2683			
Tension time index	Normal Treadmills	14	180.8557	18.0159	3.477*	0.001	Yes
	Athelets Treadmills	21	222.4181	42.0654			

Result



From the above chart and graph, it is found that left ventricular ejection time, duration of systole and ejection fraction significantly increases in athletes than in non-athletes. From this, it can be also said that it

Discussion
The present study was done to compare tension time index in athletes and non-athletes. When an individual is involved in muscular activity that is heavily dependent on oxidative metabolism, cardiac output increases in response to the demand of oxygen, which results a rise in heart-rate and stroke volume, which is facilitated by 1. Chronic effect of circulating and locally produced catecholamine, 2. Inhibition of vagal tone, 3.an increase in venous return, 4.The Frank-starling's mechanism, 5.Enhanced myocardial contractility due to inotrophic effect of catecholamine on cardiac muscles.
Normal cardiovascular response to isometric exercise includes a measure increase in myocardial contractility. More exercise, more oxygen need by tissue, more pressure on heart, increased heart-rate, increased stroke-volume, increased cardiac output (because cardiac output = stroke volume x heart-rate) i.e. increased ventricular activity, more myocardial oxygen uptake by myocardial muscle .i.e. Increased tension time index. Thus determinants of tension time index are myocardial oxygen uptake and ventricular activity. This oxygen demand is met by increasing pulmonary oxygen uptake (Vo_2) while performance of the left ventricle can also be evaluated by use of the systolic time intervals .i.e. Pre-ejection phase, left ventricular ejection phase and duration of systole.
Consistent with this hypothesis are the findings that during exercise

a. Tension time index obtained intervals from systolic time intervals consistently show changes indicating increase in myocardial contractility
b. Increase in cardiac output and stroke volume.

Thus shifting to a higher contractile state appears to be accomplished in athletes by an increase in cardiac output, with no change in systemic vascular resistance

Changes in stroke volume during exercise need to be interpreted in respect to alterations in heart rate and myocardial functional capacity. Enhancement or decrement of stroke volume can therefore be expected to serve as key markers of alterations in cardiac function and circulatory flow. The ability of athletes to exercise without increasing preload may be an effect of training and might have important implications in reducing myocardial oxygen demand during exercise.

Preload, afterload, and contractile state are the three factors that determine the performance of the ventricle. The linear relationship between peak systolic pressure and end-systolic volume closely approximates the relation between maximal tension and volume. End-systolic volume is independent of preload. (BLOMQVIST & SALTIN). Changes in stroke volume during exercise need to be interpreted in respect to alterations in heart rate and myocardial functional capacity. Enhancement or decrement of stroke volume can therefore be expected to serve as key markers of alterations in cardiac function and circulatory flow. Stroke volume progressively increases with VO2 MAX in both trained and untrained subjects same as documented through recent document. (C A Vella), which was first time recognized by Gledhill and his coworkers. The ability of athletes to exercise without increasing preload may be an effect of training and might have important implications in reducing myocardial oxygen demand during exercise.

Conclusion

Tension time index, which is a measure of myocardial activity, is increased in athletes than in non-athletes. Thus it can be concluded that left ventricular activity is much more increased in athletes than in non-athletes.

Acknowledgement

I am dedicating this paper to my beloved mother, Anjali and father, Dr. Vasantrao who are not with the world but are with me in the form of their ashirwad.

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