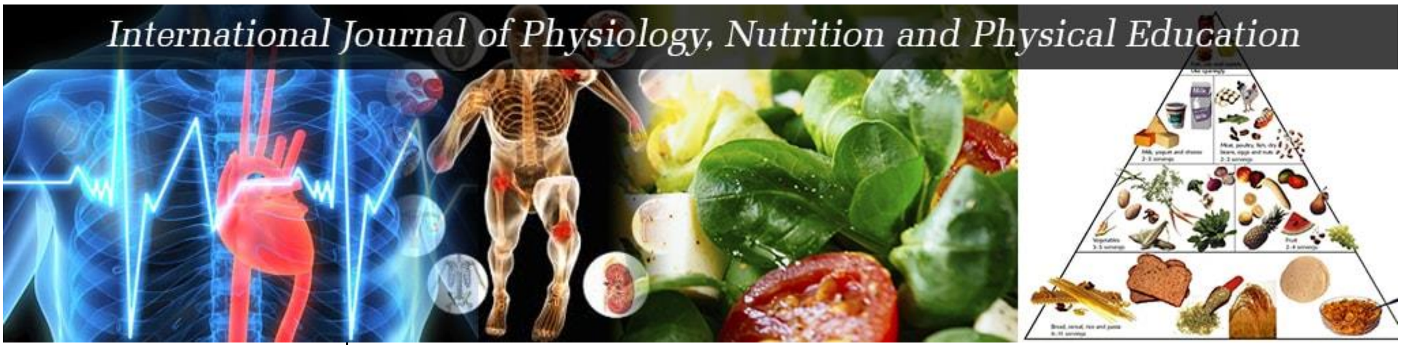

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Reliability of systolic time intervals as a measure of tension time index in athlete undergoing training

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Abstract
The goal of this study was to find how systolic time interval is a reliable measure of tension time index in athlete undergoing training tension time index and systolic time interval as a evaluator of cardiovascular fitness in athletes. Depending on the need of oxygen to tissues $\dot{V}O_{2max}$ increases with a increase in cardiac output, stroke volume, left ventricular ejection fraction and myocardial activity as a athlete does treadmill from moderate to maximal.
Data collection was done at Stress test lab. At Nerul, Navi Mumbai after taking permission from medical ethic committee. For proper results, athletes were asked to do treadmill for 2 weeks. Their systolic time intervals were assessed through 3D Echocardiography. Tension time index was calculated by using specific standardized formula.
In athletes, with a gradual increase in systolic time interval as left ventricular ejection phase and duration of systole ($p<0.001$) left ventricular ejection fraction was somewhat increased ($p<0.005$) without any change in pre-ejection phase with increase in tension time index ($p<0.001$).as athlete perform treadmill. Thus in athletes, tension time index is much more correlated with systolic time intervals ($p<0.001$).
Conclusion: Thus it was concluded that after doing treadmill, systolic time intervals is a best reliable measure of tension time index in athlete undergoing training. Thus there is a close relation between tension time index and systolic time intervals.

Keywords: Treadmill, athletes, systolic time intervals, tension time index

Introduction
Systolic time interval gives as important guidance about oxygen requirement of heart per beat. Endurance conditioning increases work capacity, reduces myocardial oxygen demand, increases potential oxygen supply. During endurance training, increase in stroke volume of an individual creates a heightened ability of the left ventricle to fill more completely during the diastole phase.
Enhancement of the intrinsic contractile properties of the myocardium, response to inotropic stimulation and extra myocardial adaptations that have secondary effects on performance of left ventricle - e.g., increased ventricular filling or decreased myocardial work.
For athletes, systolic function is often characterized by the ejection fraction, fractional shortening or stroke volume but these measures are also very complex ones determined not only by myocardial characteristics but by several other factors, as preload, afterload and autonomous regulation. Measurement of systolic time interval of the left ventricle is currently being applied in the evaluation of cardiac function. Use of PEP/LVEP ratio is very sensitive index of ventricular function.

Methodology
Data collection
Data collection was done at Stress test lab. At Nerul, Navi Mumbai after taking permission from medical ethic committee which included 40 athletes from age-group 18-24 years.
During this study, criteria kept were, BMI should be 18–24.6 m2/kg (according to National Institute of Health Science), and subject should have a 2-3 hours gap between diet and exercise and should not have cardio respiratory or orthopedic disease.
Parameters chosen were age, height, weight, systolic time intervals (pre-ejection phase, Left ventricular ejection phase, duration of systole. i.e. total electromechanical systole) derived

from Echocardiography.

After signing informed consent form, athletes were asked to do treadmill by using Bruce protocol. Duration of exercise was also taken into consideration.

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 Echocardiophy by Doppler's method, which was a standard method to record systolic time intervals, in this 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).

Normal range for pre-ejection phase - 129 msec.

Normal range for Duration of systole - 539 msec.

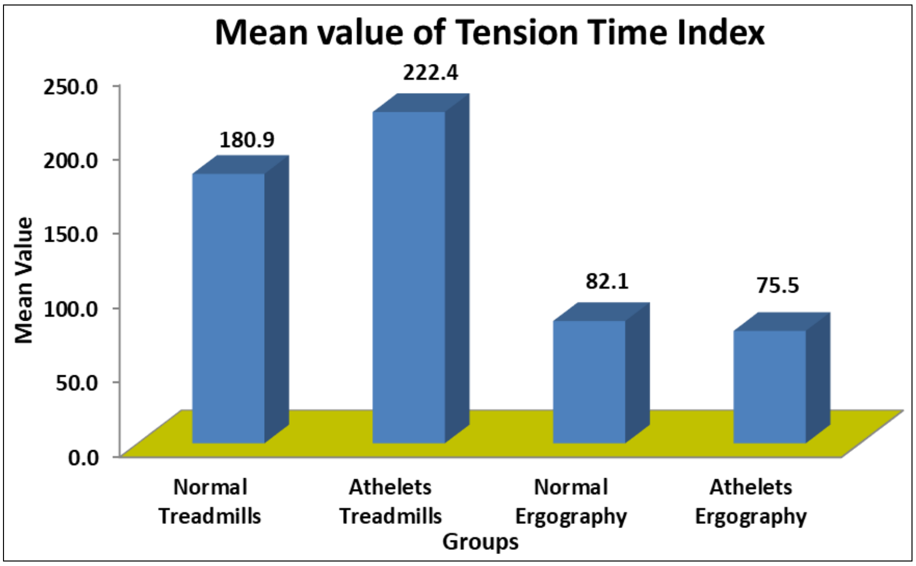
Normal range for Left ventricular ejection time - 410 msec.

Calculation of Tension Time index

Tension Time index = systolic pressure x duration of systole x pulse 85, 86).

While calculating Tension time index, duration of systole which is in msec. is converted into minute-minutes = milliseconds ÷ 60,000.

Fig 1: Calculation of Tension



Graph 1: Showing effect of Treadmill & Ergograph on Tension time index in athlete & normal

Table 1: Showing significant P-value

Parameters	Treadmill	Mean	SD	Unpaired t- Test	P-value	Significant at 5% level
Duration	Normal Treadmill	11.8329	1.2216	2.052*	0.048	Yes
	Athletes Treadmill	12.6352	1.0720			
Sys. time interval						
PEP	Normal Treadmill	65.5714	4.2193	0.750	0.458	No
	Athletes Treadmill	64.2857	5.3958			
LVEP	Normal Treadmill	288.142	21.4758	5.992**	<0.001	Yes
	Athletes Treadmill	356.285	38.6357			
Duration of systole	Normal Treadmill	350.071	23.2857	5.787**	<0.001	Yes
	Athletes Treadmill	411.619	34.8590			
Tension time index	Normal Treadmill	180.855	18.0159	3.477*	0.001	Yes
	Athletes Treadmill	222.418	42.0654			

**Statistically significant at 5% level i.e., $p<0.05$

**statistically highly significant at 0.01% level i.e., $p<0.001$

Table and graph shows a close correlation between systolic time interval and tension time index in athletes and non-athletes after performing treadmill at suitable duration required for obtaining maximal response. ($p<0.005$) while systolic time intervals as left ventricular ejection phase, duration of systole was found to be much more increased ($p<0.001$) without any change in pre-ejection phase.

While Tension time index, which is derived from systolic time interval was found to be much more increased in athletes performing treadmill as compared to non-athletes performing treadmill (increased).

Thus our results show that in athletes, there is an increase in work capacity, increased myocardial oxygen demand at any given maximal work. Tension time index is used to estimate myocardial oxygen demand, which correlates well with myocardial oxygen consumption.

Discussion

This study demonstrates that in athletes, echocardiographic parameters showing functioning of left ventricle are mainly and positively correlated to Tension time index. In athletes, there is an increase in work capacity, increased myocardial oxygen demand at any given sub-maximal work. Thus a direct co-relation was found between Tension time index and systolic time intervals in athletes which clearly reveals that a systematic, graded program of physical conditioning can produce significant hemodynamic alterations in a group of athletes [12].

Endurance trained subjects have significantly longer ventricular ejection times, greater myocardial contractility, greater left ventricular diameter and mass and significantly shorter diastolic filling times than untrained subjects [14].

Cardiac adaptations in these master athletes are manifested by left ventricular enlargement and enhancement of left ventricular systolic performance during exercise as evidenced by [1] a significant decrease in end-systolic volume during exercise in the master athletes despite similar increases in systolic blood pressure in the trained and untrained men, a larger left ventricular exercise reserve, a greater rise in ejection fraction in the master athletes at comparable increases in end-diastolic volume during exercise in trained and untrained persons. Greater rise in stroke volume provides evidence of enhanced left ventricular function independent of pre-load. Greater rise in stroke volume provides evidence of enhanced left ventricular function independent of pre-load [5].

As per Douglas R. Seals cardiac adaptations in athletes are manifested by left ventricular enlargement and enhancement of left ventricular systolic performance during exercise by a significant decrease in end-systolic volume during exercise in athletes despite similar increases in systolic blood pressure in athletes and non-athletes, a larger left ventricular exercise reserve, a greater rise in ejection fraction in athletes at comparable increases in end-diastolic volume during exercise in athletes and non-athletes. Greater rise in stroke volume provides evidence of enhanced left ventricular function independent of pre-load. These adaptations are mediated by several mechanisms [16].

As work load of ventricle increases, although stroke volume remains stable myocardial contractility increases, shortening ejection time. An increase in stroke volume or myocardial contraction results in a decrease in pre-ejection period with a rise in arterial pressure.

The maximum rate of work that can be performed is limited by combined capacities of cardiovascular and respiratory system to take in, transport and use oxygen. Systolic time intervals (STI), in particular the pre-ejection period (PEP), are demonstrated to reflect cardiac sympathetic influences on myocardial contractility. Thus, monitoring the response of systolic time interval measures during exercise and recovery may provide insights into cardiac sympathetic activity (inotropic influences) [6].

Thus maximum oxygen intake measures functional capacity of cardiovascular system and is useful criteria for assessment of overall capacity to perform work.

Conclusion

After doing treadmill, it is concluded that systolic time intervals is a best reliable measure of tension time index in athlete undergoing training. Thus there is a close relation between tension time index and systolic time intervals.

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