A Study of Electrocardiographic and Echo-Cardio Graphic Adaptive Changes in Endurance Athletes

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Abstracts: Background & objectives: There is great public and scientific interest in the status of exercise and physical fitness among the preadolescent and adults. The physical activities should increase to intervene health problems since it emphasizes wellness and promotes self-awareness. Heart is the only organ facing overload of the regular physical exercise. The structure of athletes' heart or physiological variations associated with training leading to left ventricular hypertrophy has been referred as Athlete's Heart syndrome. **Methods:** To evaluate the prevalence and importance of "physiological" left ventricular hypertrophy (LVH) in athletes, the electrocardiographic and echo-cardio graphic parameters of 40 track and field runners were studied. **Results:** Electrocardiographic evidence of resting bradycardia, LVH, present in athletes, was associated with concomitant echo-cardio graphic evidence of a thickened left ventricular (LV) posterior wall, with an enlarged end-diastolic LV diameter. Cardiac hypertrophy and dilatation commonly develop in well-conditioned athletes. **Interpretation & conclusion:** Enlargement (increase in diameter by echocardiography) in the left ventricular cavity associated with physiological LVH characterized by increased voltage in ECG & posterior wall and IVS by echo-cardio graphic thickness play important role in maintaining optimal cardiac performance during training as well as competition and normal cardiac performance at rest. [Warkar A NJIRM 2014; 5(4) :51-55]

Key Words: Athletes heart, Left ventricular hypertrophy, resting bradycardia.

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Introduction: If the health of human being in the last few decades is gauged, then it is observed that the results of the clinical advances are better but at the same time we have also witnessed increased morbidity due to age related chronic diseases. One important measure of this morbidity is the person's daily sedentary life style. In old age this sedentary life style is associated with cardiovascular mortalities along with increased incidence of diabetes mellitus. Present prospective holds that the modern

urban people spend most of their time in leisure sedentary activities. In the day to day life the adult & aged are found to be busy in the table work & thus the physical activities are restricted.

There is great public & scientific interest in the status of exercise and physical fitness among the pre-adolescent & adult.

A well planned program is therefore necessary for an active and productive life style. This will lead to Physical and Psychological health restoration. In an attractive approach the physical activities should increase to intervene health problems since it emphasizes wellness & promotes self-awareness. But then regular and continuous physical exercise may lead to overloading of heart and cardiovascular changes. The study of these cardiovascular changes due to physical workload is also a topic of concern as in most of the research studies of athletes doing regular physical exercise. These changes due to physical training are referred as athlete heart syndrome [(1)]. Hence the study is planned and designed to study the cardiac adaptive changes in athletes doing regular physical training.

Aims and Objective:

- The purpose of this study is to determine whether, intense, long term physical training causes the left ventricle to develop different mechanisms for increasing the cardiac efficiency
- To assess the structural, functional & electrophysiological effects of endurance running on cardiovascular system.
- To find out physiological cardiovascular adaptations that occurs in Athletes and compares them with non-Athletes.

Material and Methods:

Selection of Subject: 1. Athletes: A group of 40 male Athletes consisting of track and field runners was selected. The criteria for selection of the

group was that , they should have at least 4 – 5 years of Athletes activities for a minimum period of 5-6 hours daily in morning & evening. They should be participant in Athletes activities at District, State & national level.

2. Non- Athletes: - The control group consists of 40 male medical students of IGGMC, Nagpur. They were non-Athletes means did not participate in regular running, jogging, swimming, or in any other sports.

Both the groups were matched in age (18-22 years) but there was slight variation in their weight and height. They were selected after complete medical examination. Detail family history was obtained to rule out the risk factors like hypertension, diabetes mellitus or cardiovascular disorder or any other ailment. Special care was taken to see that none of them was on digitalis, propranolol or having history of chest pain, palpitations or breathlessness. Informed consent was obtained in every case& study was approved from Institutional ethical committee.

Equipments Used:

1. Cardiart 108 T-MK-VI, single channel, 12 lead electrocardiographs was used to record the ECG.
2. For Recording Left Ventricular Dimensions (Echocardiography)

✓ An Ekaline 20A ultrasonic echoscope was used.
✓ A transducer with a frequency of 2-2.5 MHZ was used with a beam widening of 6 to 8 mm.

For Recording Ecg:

The ECG were recorded in 12 standard leads i.e. unipolar limb leads I, II, III, augmented unipolar limb leads i.e. aVR, aVF, aVL, and precordial leads from V1 to V6 and the following parameters were selected.

- Heart rate in Lead II
- PR interval from lead II
- QRS interval in lead V1 and V3
- Height of R wave in V6 in mm.
- Depth of S wave in lead V1 in mm.
- The sum of S wave in V1 + R wave in V6 in mm [2].

Note: The voltage criteria are denoted in mm, as in many studied references the referral is made in mm only.

For Echocardiography: All echo cardio graphic examinations were performed with the echoscope using 2.25 MHz frequency with 1.59 cm transducer focused at 10 cm and the following parameters were studied. LVIDd, LVIDs, PWT, IVST, EDV, ESV, SV, EF

Statistical Methods Used: The statistical analysis of observations was done. The mean and standard deviation (SD) were calculated for all the parameters by the following formulae. Student t-test was applied for the significance of this statistical analysis by using unpaired t-test.

Observations: Result are shown in following table

Table 1: Electro-Cardiographic Observations

Sr. No.	Parameters	Athletes		Non – Athletes	
		Mean/SD	Range	Mean/SD	Range
1	HR (In Minute)	52.47± 7.28	42 – 68	78.57 ± 5.09	64 – 88
2	PR (in Second)	0.184 ± 0.01	0.14 – 0.18	0.15 ± 0.01	0.14 – 0.18
3	QRS(in Second)	0.09± 0.013	0.06 – 0.1	0.046± 0.009	0.04 – 0.06
4	Sum of RV6 + SV1 (mm)	35.55± 2.74	32 – 45	21.4± 4.37	12 – 31

1mm = 0.01 MV.

Table 2: Echo-Cardiographic Observations

Sr. No.	Parameters	Athletes		Non – Athletes	
		Mean/SD	Range	Mean/SD	Range
1	LVIDd	53.45 + 2.33	51 – 58	42.92 + 2.43	39 – 49

2	LVIDs	33.1 + 3.27	29 – 42	31.67 + 1.32	29 – 36
3	PWT	9.07 + 0.67	8 – 10	8.57 + 0.50	8 –9
4	IVST	9.35 + 0.69	8 – 9	8.9 + 0.74	8 – 10
5	EDV	159.87 + 14.88	134 – 191	79.05 + 9.94	64 – 94
6	ESV	32.775 + 5.82	22 – 42	28.4 + 5.71	20 – 40
7	SV	127.5 + 13.31	110 – 164	50.62 + 6.34	44 – 64
8	EF	79.4 + 3.40	87 – 75	62.6 + 7.59	50 -72

(LVIDd, LVIDs, PWT, IVST ---- IN mm), (EDV, ESV, SV ---- IN ml),(EF - IN %)

Table 3: Comparison of Athletes Vs Non-Athletes ECG

Sr. No.	Parameter	p Value
1	HR	< 0.001(S)
2	PR	< 0.001(S)
3	QRS	< 0.001(S)
4	Sum of RV6 + SV1	< 0.001(S)

S = Significant

Table 4: Comparison of Athletes Vs Non-Athletes Echo-cardiography

Sr. No.	Parameter	p Value
1	LVIDd	< 0.001(S)
2	LVIDs	< 0.05(S)
3	PWT	< 0.001(S)
4	IVS	< 0.01(S)
5	EDV	< 0.001(S)
6	ESV	< 0.005(S)
7	SV	< 0.001(S)
8	EF	< 0.001(S)

S=Significant

Discussion: Cardiac enlargement in Athletes trained for endurance has been recognized for many years as an adaptive change. The slight difference in weight of Athletes (55kg) & Non-Athletes (61.6kg) in our study is attributed to the difference in the amount and degree of habitual physical activities and the body composition in both the groups.

ELECTROCARDIOGRAPHIC PARAMETERS (as shown in Table No. 1)

Heart Rate: In the present study resting heart rate is observed to be 52.47 beats per minute in ATHLETES while 78.57 beats per minute in NON-ATHLETES. Thus statistically highly significant resting bradycardia is noted in ATHLETES. . This resting bradycardia in Athletes can be attributed to the relative increase in the dominance if parasympathetic or vagal tone on rate of impulse at the S.A. node. Heart rate is basically influenced by vagal and beta adrenergic activity.

Probably there may also be intrinsic slowing of impulse generation at the pace maker [3]. Stretch receptors initiated hypertrophied atria might also contribute to bradycardia [4].

P-R Interval : Highly significant delayed conduction time or prolongation of PR interval 0.18 sec in athletes and 0.15 sec in non-athletes, reported in the study can also be due to increased influence of vagal tone on the pace maker and the conducting system[4].

QRS Complex: In the present study the mean QRS complex duration is observed to be 0.09 sec in athletes and 0.046 sec in Non-athletes. This widening of QRS complex associated with prolonged PR interval is likely to be due to slightly delayed depolarization of ventricles suggestive of physiological left ventricular enlargement or hypertrophy[5.]

Sum of SV1 + RV6: As per the Sokolow Lyon's electrocardiographic voltage criteria for left ventricular hypertrophy, 55 % of the athletes have the mean sum of RV6 + SV1 35.55 mm suggestive of left ventricular hypertrophy. Such excessive

precordial voltage is common finding representing hypertrophy alone or combination of hypertrophy or dilatation in Athletes [6]. Whether widening in QRS complex and increased voltage of QRS complex is observed in the present study are due to dilatation of left ventricular chamber or due to LVH can be precisely commented with the help of echocardiography.

ECHOCARDIOGRAPHIC CHANGES: LVIDd & LVIDs Statistically significant increase in LVIDd during diastole & less significant increase in LVIDs in ATHLETES are suggestive of increase in the size of left ventricular cavity during diastole responsible for more reserve capacity & stroke volume at rest[7].

PWT & IVST Statistically significant increase in dimensions are the structural change taking place in the posterior wall of the left ventricle & inter ventricular septum as ATHLETES are regularly subjected to heavy endurance training for hours every day[8]. To pump out demanded volume of blood with each stroke more forceful contraction of heart is required which is achieved by bringing about hypertrophic changes causing at the left ventricle increasing in the thickness of posterior wall of left ventricle.

EDV : The highly significant increased EDV is attributed to bradycardia allowing more filling time and increased ventricular accommodation of blood due to increase in the radius of the chamber[9]. Thus per stroke more volume of blood is available for ejection.

ESV: This observation also indicates ejection of more volume of blood leaving comparatively less volume of blood in the left ventricle at the end of systole [7].

SV: All the above changes indicate pumping of increased volume of blood by particularly left ventricle per stroke. As it is associated with bradycardia, heart can economically pump out normal volume of blood (cardiac output) per minute with less energy expenditure [10].

*EF %***:** again this increase in EF is observed in the present study can be explained on the basis of statistically increased EDV. As more volume of blood is received in more time available, more volume of blood is ejected per stroke [11].

Due to resting bradycardia more time is available for ventricular filling causing more stretching of the myocardial fibres, increasing end diastolic diameter. This increased size of left ventricular chamber is responsible for increasing reserve capacity of the chamber and enables the left ventricle pump out more volume of blood during each stroke with increased force [12].

Physical fitness of long distance runners requires a large increase in cardiac output for an optimal effort. The endurance runners often sustain this hemodynamic burden for many hours of each day. Resting bradycardia accompanied by increased stroke volume so that at rest very little change in cardiac output takes place. Thus contractile performance of the heart is adjusted to maintain the resting cardiac output, which clearly indicates the improvement in economy of heart muscles in respect with energy requirement and demand of O2 due to endurance training.

Linzbach coined the term “Physiologic Hypertrophy” on the basis of observations found in the heart of labourers. The physiological hypertrophy in the Athletes does not lead to ischemic type of response during exercise. This physiological LVH however contributes to superior ventricular function. The stimulus of this hypertrophy is due to repeated stress of competitive sports which elicits a normal response in the cardiac muscles resulting in hypertrophy that is balanced between the two ventricles and it corresponds to the load induced by the exercise level [12].

From the above observations in endurance ATHLETES it is evident that enlargement (increase diameter by echocardiography) in the left ventricular cavity associated with physiological LVH characterized by increased voltage in ECG & posterior wall and IVS by echo-cardio graphic thickness play important role in maintaining optimal cardiac performance during training as well as competition.

Conclusion: These adaptive changes enable the heart of an athlete to pump out required volume of blood with less expenditure of energy. Similarly during exercise such heart can easily cope up with the increasing demand of O2 and nutrients by exercising muscles. During exercise venous return is tremendously increased which is responsible for further increased filling of ventricles inspite of increase in the heart rate. This increased volume of blood received by heart is efficiently & forcefully pumped by physiologically hypertrophied left ventricle.

The above adaptive changes taking place in athlete's heart are physiologically though the range of CVS findings is above normal. Clinicians must consider this higher range in case of athletes as normal to avoid wrong interpretation of the ECG and Echo-cardio graphic parameters for diagnostic purpose. It sparks in mind that history of physical exercise exposure is to be accounted in clinical history of patients.

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