NON INVASIVE CARDIOVASCULAR EVALUATION OF THE HIGHLY TRAINED ATHLETE

THESIS

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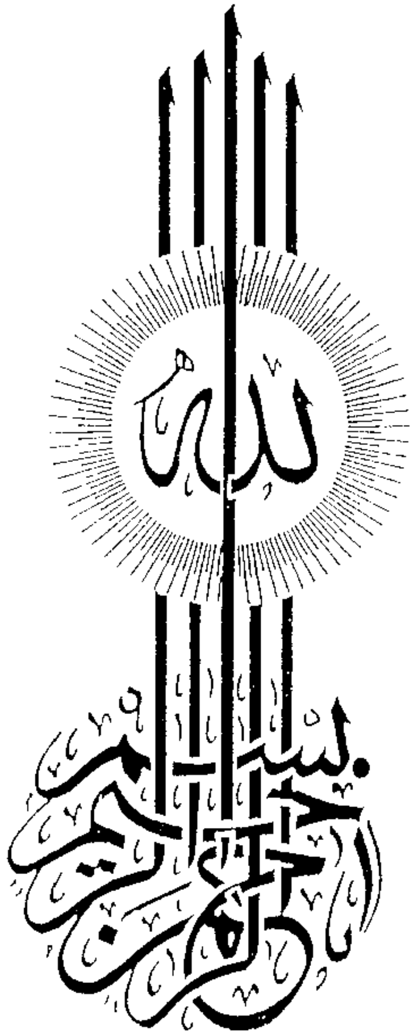
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C O N T E N T S

INTRODUCTION

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Participation in sports has emerged as a major facet of the present day life style involving a large proportion of the population, individuals of all ages and a wide variety of athletic endeavors. Much of this accelerated interest has been in competitive athletics encompassing growing number of both youthful and older participants in organized individual and team sports. In addition in 1979 the American Heart Association recommended that it is prudent for the general population to exercise moderately each day.

It is now well known that athletes actually develop compensatory cardiovascular changes that represent an adaptation to long term stress.

Parallel developments in cardiology and cardiovascular diagnosis during the last 10 years have provided us with a more refined and precise concept of the normal athlete heart.

AIM OF THE WORK

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1. To survey the different changes in the cardiovascular system in Egyptian athletes by standard non invasive tools.

2. To find if there is any correlation between these changes and the maximum oxygen consumption which characterizes the functional limits of the cardiovascular system to deliver oxygen to satisfy aerobic requirements.

REVIEW OF LITERATURE

CARDIOVASCULAR AND LOCAL ADAPTATIONS TO PHYSICAL TRAINING

In 1628 William Harvey said, "The more muscular and powerful men are the firmer their flesh, the stronger, thicker, denser and more fibrous their hearts the thicker and stronger are the auricles and arteries. (Steinhaus, 1932).

The recognition of the acute and chronic physiologic adaptations of the cardiovascular system which occurs as a result of intensive prolonged physical work exertion is of importance, because the changes which result are similar in many respects to those seen with disease. (Beckner and Winsor, 1954).

The improvement in physical performance capacity that results from regularly performed vigorous exercise (physical training) is an example of biological long term adaptation to increased chronic stress. It involves multiple adaptive reactions occurring primarily in the skeletal muscle fibers, in the nervous system and in the circulatory system. The relative effect on the different physiological functions and the nature of the changes depend specifically on the type of the exercise chosen for training. (Clausen et al. 1971).

With isometric exercise the heart rate increase was found to be modest, but the systolic blood pressure showed precipitous rise. (Ehsani et al. 1978).

Left ventricular function during sustained isometric handgrip exercise was studied at the time of cardiac catheterisation. The response in normal healthy subjects consisted of an increase in left ventricular stroke volume, minor changes (average increase of 2 mmHg) in left ventricular end-diastolic pressure, heart rate, aortic mean blood pressure and cardiac minute output with no change in systemic vascular resistance. Significant increase were consistently observed in the isovolumic indices of myocardial contractility: V max (developed pressure) and maximum left ventricular dp/dt . (Helfant et al. 1941 & Quinones, 1974). Since the blood pressure increases significantly despite minimal changes in systemic vascular resistance it is conceivable that the elevated arterial pressure response is due mainly to increased cardiac output.

These findings indicate that the normal left ventricle responds to this form of exercise by improving its contractile state and to a minor degree by increasing preload thus maintaining a constant stroke volume in the presence of an increased afterload. (Helfant et al. 1971).

To test whether the increase in contractility observed during isometric exercise was related to the increase in heart rate, isovolumic indices of contractility were measured during atrial pacing at a rate equal to that achieved during exercise. Isometric exercise was associated with a higher level of myocardial contractility than atrial pacing. In addition a significant improvement in the isovolumic indices was observed in patients subjected to isometric exercise at a constant heart rate (atrial pacing).

Thus it seems that in addition to the treppe effect other factors independant of heart rate are involved in augmenting contractility during isometric exercise. (Quinones, 1974).

Dynamic activity causes an increase in heart rate that parallels activity intensity and an increase in stroke volume. Systolic blood pressure increases gradually with maintenance of, or slight decrease in diastolic blood pressure. Increased oxygen extraction widens the systemic arteriovenous oxygen difference. (Hurst, 1982).

Dynamic exercise produced significant abbreviation of the mean QS_2: (the interval between the Q wave of the electrocardiogram and the second heart sound), LVET: (Left ventricular ejection time) and PEP: (preejection period). Isometric exercise at comparable heart rate produced significant abbreviation of the mean QS_2 and LVET but not of the PEP. (Bock and Andrew, 1977).

Effect of training on circulatory adjustments to maximal exercise:

A. Maximal oxygen uptake: standard of reference:

The single laboratory procedure used most often to evaluate the strenousness or intensity of an exercise is the measurement of oxygen consumption. Since oxygen uptake is the product of cardiac output and quantity of oxygen extracted from each unit of circulating arterial blood (Arteriovenous oxygen difference), it is apparent that these are the only two mechanisms for increasing the supply of oxygen to the tissues. Actually both mechanisms are used simultaneously. (Freedman et al., 1955).

The linear relationship between heart rate and oxygen consumption at submaximal and near maximal work loads permits the use of heart rate to estimate the strenousness of exercise. (Schewer and Tipton, 1977).

The amount that VO_2 max increases with training is inversely proportional to the preconditioning VO_2 and to age. (Hurst, 1982).

In a given subject the highest value for maximal oxygen uptake is attained during exercise with great muscle groups i.e. normally during leg exercise. Apparently most subjects achieve their individual absolute maximum when running but some will reach still higher values if they perform isometric arm exercise concomitant to treadmill walking. (Rowell, 1974).

It is conceivable that one of the adaptations of atheletic training might permit the athlete to increase oxygen extraction per unit of circulating blood during exercise. Such a mechanism would allow the trained athlete to consume a given amount of oxygen at a low cardiac output than required by the untrained individual tending thereby to lower the burden placed on the athlete's heart during strenuous exertion. (Astrand, 1956).

During exercise the reserve source of oxygen carried in the venous blood is called upon more and more until exercise capacity is reached both in the trained and the untrained athlete and probably in normal individuals as well. Since the maximum work capacity of the ordinary individual is less than that of the trained athlete undoubtedly this reserve of oxygen is called upon at lower exercise levels in the former than for the latter. (Freedman and Snider, 1955). The unloading of oxygen from the blood passing through the muscle tissue is enhanced by an increase in temperature and decrease in PH (Bohr effect).

The heavier the work the faster are the changes which might increase the arteriovenous oxygen difference. (Rowell, 1974).

Maximal oxygen consumption characterizes the functional limits of the cardiovascular system to deliver oxygen to satisfy aerobic requirements. Assessment of maximal oxygen