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Functional Capabilities of the Heart of Young Men Who Regularly Experience Muscle Loads

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Abstract

To improve the health of modern youth, regular training is needed to further assessment the influence of different types of physical activity on the young organism, especially in the process of adaptation of the heart of young athletes. The purpose of this study is to trace the dynamics of the physiological parameters of the heart in adolescent tennis players. This study was performed on 27 clinically healthy adolescent tennis players with at least two years of training experience. The control group consisted of 22 clinically healthy young men who had never been involved in physical culture or sports. The observation was performed using the SSD-80 "Aloka" ultrasonic device (Japan). With its help, several functional indicators of the heart were taken into account. Statistical analysis of the results of the work was performed using Student's t-test. The examined tennis players showed signs of slight hypertrophy of the left ventricular muscle. This was indicated by an increase in the diameter of the muscle in its posterior wall and an increase in the mass of the left ventricle of the heart. In all tennis players, the left cardiac ventricle volume was perfectly normal. Tennis players also had an optimum diastole time. Regular tennis lessons strengthen all of a person's internal organs. They increase left ventricle muscle mass, which increases its function.

Keywords: Heart, Tennis, Function, Left ventricle, Myocardium, Physical activity

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Introduction

Frequent feasible physical activity optimizes all vital characteristics of internal organs (Khitrov & Paukov, 1991) and activates the biochemical mechanisms of their functioning (Zavalishina, 2020; Karpov *et al.,* 2021a). Low muscle activity in all cases contributes to the weakening of the viability of the organism as a whole and its internal organs (Medvedev, 2018b) and, first of all, the heart (Bespalov *et al.*, 2018a; Alzahrani *et al.,* 2019; Mal *et al.*, 2020; Permadi *et al*., 2020). Regular physical training increases the volume of working muscles (Makhov & Medvedev, 2021) and activates all biological processes in them (Skoryatina & Zavalishina, 2017). At the same time, in skeletal muscles, there is an increase in adaptation processes and all components of metabolism (Kotova *et al.*, 2017; Zavalishina, 2018b). The need to improve the schemes of sports training requires the continuation of studies of their influence on various parameters of cardiac activity (Khitrov & Paukov, 1991; Medvedev, 2021). Especially great importance is attached now to the dynamics of the contractile capacity of the heart in the conditions of various sports training (Karpov *et al.*, 2020a; Zavalishina *et al.*, 2021a).

Often, physically well-prepared athletes have an increase in the volume of the entire myocardium, primarily in the left ventricle, which often leads to a decrease in the volume of cardiac cavities (Dembo & Zemtsovsky, 1989; Medvedev *et al.*, 2021). In those who have committed systematic sports training, systolic output often decreases as the period of regular physical activity increases (Khitrov & Paukov, 1991; Karpov *et al.*, 2021b).

Considering the enormous importance of normal heart function for the life process, the implementation of any adaptation processes, including sports (Bespalov *et al.*, 2018b), it is necessary to take into account the dynamics of his work in the conditions of various types of regular physical activity (Makurina *et al.*, 2020; Zavalishina *et al.*, 2021b), including playing tennis. For a more complete assessment of the influence of tennis on the body of young athletes, a further assessment of its influence on the functional characteristics of the heart in well-trained tennis players is required.

Purpose: to trace the dynamics of the physiological parameters of the heart in youth tennis players.

Materials and Methods

The study was conducted on clinically healthy young men aged 17 to 21 who are university students. An observation group was formed of 27 young men who regularly played tennis for an hour a day at least 4 times a week. Their tennis training experience was at least 2 years. A control group was also collected, which included 22 clinically healthy university students (aged 17 to 21 years) who had never played sports and experienced physical activity higher than household only during university physical education classes 2 times a week. The study was carried out using an ultrasonic device SSD-80 "Aloka" (Japan). Taking into account the obtained indicators, the value of the diastolic volume of the heart was calculated. Using a standard method, the value of the mass of the heart muscle was determined. The ratio of the muscle mass of the left cardiac ventricle and the volume of its cavity was estimated by calculating the value of the end-diastolic cardiac volume index.

Statistical processing of the data obtained during the study was carried out using the Student's t-test. The significance of the differences between the observed groups was established in the case of $p < 0.05$.

Results and Discussion

The conducted research made it possible to find the differences in the registered parameters in tennis players and physically untrained young men **(Table 1)**. The differences between the observation groups can be associated with the features of the morphological parameters of the muscle of the left cardiac ventricle, formed under conditions of regular physical exertion (Dembo & Zemtsovsky, 1989).

The lateral size of the left atrium in the tennis players taken under the supervision was 9.2% more than this indicator in the physically untrained persons of the control group. This indicated a slightly greater adaptation of the heart muscle of athletes to any physical activity (Zavalishina, 2018a; Vorobyeva *et al*., 2020). In tennis players, the anteroposterior diameter of the left ventricle of the heart during diastole exceeded 9.6% in the group of physically untrained young men. The found differences are a consequence of the greater severity of anabolic processes in the heart muscle in tennis players.

The thickness of the myocardium in diastole in the posterior wall of the left ventricle in tennis players exceeded 21.9% in young men included in the control group ($p<0.01$). This is caused by more active functioning of the left cardiac ventricle in tennis players undergoing regular physical activity (Medvedev, 2018c). The heart volume during diastole in tennis players tended to decrease by 7.1% in comparison with the level in the control. The value of the stroke volume in boys of both groups was comparable, which indicated the optimal hemodynamic properties of the heart in all the examined (Medvedev, 2018a; Karpov *et al*., 2020b).

Table 1. Indicators registered in the work

Heart function parameters	Group of tennis players, M±m, n=27	Control group, M±m, n=22
Ejection fraction, %	62.04±1.29	60.10±1.05
End diastolic volume of the heart, cm^3 / kg	1.83±0.19	1.96±0.16
Impact volume, cm3 / kg	1.10±0.31	1.04±0.11
Anteroposterior diameter of the left ventricle in diastole, cm	5.59±0.36	5.10±0.32
Myocardial mass, cm^3/kg	2.75±0.24	2.11±0.18 p<0.05
End-diastolic volume to myocardial mass, cm^3/kg	0.63±0.26	0.98±0.12 p<0.01
The diastolic thickness of the left ventricle in the posterior wall, cm	1.28±0.17	1.05±0.10 p<0.01
The greatest relaxation rate of the left ventricle in the posterior wall, cm/s	14.1±1.37	10.2±0.96 p<0.05
Left atrium diameter, cm/m^2	1.97±0.16	1.72±0.12
Reduction of the anteroposterior size of the left ventricle,%	35.63±0.47	32.72±0.61

Note: p is the mathematical significance of the differences in the estimated indicators between the groups under consideration.

In tennis players, the myocardial mass turned out to be 27.7% more than in young men who did not experience regular sports physical activity. This indicated the appearance of physiological hypertrophy of the heart muscle against the background of systematic tennis training (Khitrov & Paukov, 1991) At the same time, its presence did not affect the shape and size of the heart cavities and the volume of systolic ejection (Raspopova *et al*., 2020; Zavalishina *et al*., 2021c). The value of this volume turned out to be similar in both observation groups, indicating the optimum in all observed functional capabilities of the heart (Skoryatina & Zavalishina, 2017).

Acceleration of relaxation processes was found in the muscle of the posterior wall of the left ventricle of the heart in tennis players. In these boys, this indicator turned out to be higher than the values obtained in the control group by 38.2% due to an increase in the volume of their cardiomyocytes (Kotova *et al.*, 2017).

The ratio of the diastolic volume and heart muscle mass in tennis players was lower than in young men in the group control by 55.5%. This is due to the high sensitivity of this parameter to systematic physical training, which has an aerobic character (Dembo & Zemtsovsky, 1989; Medvedev *et al*., 2009).

The performed assessment showed the similarity in both groups of young men in the size of the left atrium, the size of the total volume of the left ventricle, and the size of its cavity. All the subjects were found to have similar parameters of their central hemodynamics and the potential of the heart to normal activity. The ratio of the

value of the final diastolic volume of the heart to the value of myocardial mass in the course of regular tennis training decreased as a result of an increase in the volume of the whole heart and myocardium in the posterior wall of the left cardiac ventricle. The decrease in the ratio of the end-diastolic volume to the value of the myocardial mass in tennis players to 0.63±0.26 is the result of the prevalence of hypertrophy processes in them over the phenomena of dilatation in all parts of the heart (Zavalishina, 2020; Glamazdin *et al*., 2021).

Apparently, in the case of regular tennis training, persistent hypertrophy of the muscle of the left ventricle of the heart occurs. This is evidenced by the tendency to increase the thickness of its posterior wall and an increase in its mass while maintaining the size of the cavity of the left cardiac ventricle at the normal level (Vorobyeva *et al*., 2020).

The physiologically beneficial acceleration of diastole development in tennis players occurs as a result of systematic aerobic training (Bespalov *et al*., 2018c; Mal *et al*., 2020). This is confirmed by the higher relaxation rate of the posterior wall of the left cardiac ventricle in tennis players. At the same time, this indicator in the course of the ultrasound examination is quite variable and can change during one examination in one person. Given this circumstance, additional observations are needed on different categories of athletes to develop a correct understanding of this indicator.

Conclusion

Systematic tennis at adolescence can stimulate the heart muscle and normalize overall hemodynamics. Regular dosed loads during tennis training increase the mass of the heart muscle, especially in its left ventricle, and do not affect the normal volume of its cavity. For experienced tennis players, a high speed of the onset of diastole with complete relaxation of the posterior wall of the left ventricle of the heart is very characteristic. The revealed changes in the ultrasound parameters of the heart in tennis players prove the great usefulness for the myocardium of regular tennis lessons in adolescence.

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