1935), coronary changes can be also observed. Irrespective of the young age of people engaged in sports, it has been established that while moderate physical exertion prevents the arteries from sclerosis, the excessive loads can play the role of an additional patogenetic factor (Lang, Myasnikov). The histomorphological studies of Sarkissov and co-authors, Lihatchewa and Pintchuk confirmed these ideas.

Personal as well as literature data illustrate our basic belief that the chronic overstrain of the heart (resulting from the discrepancy between physical stress and functional capacity) is a hazard to the health of athletes, potentially existing in conditions of hard training.

The second problem of sports pathology which we would like to deal with is the problem concerning athletic microtraumatism.

Fig. 4 presents the microtraumatism to acute injuries ratio. While in 1958 according to our investigations, the percentage of microtraumatism was 18.6 % of the total number of injuries, in 1973 the percentage of mirco traumatism increased to 30.2%. The cause for this increase in the percentage of microtrauma within the general structure of athletic injuries is the existing discrepancy between high physical exertion and the functional reserves of the musculo-skeletal system. This is confirmed by the data presented in the same figure. In club team competitors, microtraumas amount to 25.4% of the total incidence of ijuries. In national competitors whose training is characterized by high, excessive loads, the percentage of microlesions is considerably higher - 45%.

Making errors in the methods of athletic preparation under conditions of hard training might account for disturbances in the processes of musculo-skeletal tissue restoration. The overlaping of similar disturbances in the anatomic and histologic structure may result in morbid conditions some of which could even be differentiated as nosologic entities or syndromes. In 1936, Betzner V. elucidated some noxious conditions of physical labour and sport. In his extensive and well-grounded report submitted at the International Conference on Sports Medicine in Berlin in 1954, Lange described comprehensively the pathological changes in muscles, tendons, ligaments and bones of athletes subjected to excessive work loads. Later investigations showed that when an inadequate correlation exists between functional demands and capacity of the organism, pathological changes occur in the locomotor apparatus tissues, as follows:

In tendons a premature degeneration is noted with lypoid deposit, firstly diffuse, without intracellular alterations. Later, true lypoid nodes are formed. Such a tendon is easily disrupted when subjected to a sudden load. Our investigations on prepatellar tendon showed that degenerative changes may involve partially only in the most loaded part of the tendon transforming it into a hard, nonelastic cord. Simultaneously, changes occur in the attachment zone of the tendon, corresponding to the cord insertion where partial insertionitis or a chronic degenerative periostitis develops.

In muscles myogeloses are formed initially. They are circumscribed muscular hardenings decreasing the elasticity and contractility of muscles. At sudden efforts small ruptures can occur, healing with scars. The muscle tone increases but its strength and elasticity decrease. Continuously repeated overloadings lead to a degenerative atrophy of muscles with an increased susceptibility to ruptures. A peculiar form of a chronic muscular lesion is the ossifying myositis, which is more frequently observed in gymnasts and throwers within the elbow joint region, and sometimes in the adductors of the femur ("rider's bone").

In bones osteodystrophic changes and morbid reorganization take place. The so-called "zones of fatigue" of Looser, as well as "the zones of bone reconstruction" which have been described recently are attributed to the effect of overloading. Diffuse peiostitis of the tibia and fibula in runners and jumpers caused by overloading, as well as local periostitis in the insertion sites of muscles to bones (insertionitis) where often, besides the periosteum, the degenerative changes involve the tendons are also described. In the neighbourhood of tendon attachments, true bone "spurs" are formed. The periostitis is converted into a real periostosis. Under the raised periosteum a true new bone formation takes place.

In joints, at the beginning signs of loosening and irritation of the joint capsule with a tendency to intra-articular exudates are detected. The hyaline cartilage degenerates and signs of rheumatoid arthritis appear. In the knee joint the degeneration often affects the menisci. Sometimes periarticular calcifications are present. The ligaments become loose. Similar are the degenerative changes observed in the so called "football knee". The cartilaginous degeneration in intervertebral discs marks the onset of intervertebral chondrosis with the corresponding symptoms and complaints.

All described pathological changes in the locomotor apparatus of athletes, occurring as the result of overloading conducted with improper methods, are reversible when correctly treated at their early stage. In more advanced stages, some of them are differentiated as separate nosologic entities or syndromes. This group includes the peculiar form of myofascitis with diffuse periostitis of the leg in runners described by Bankov and called "dynamic periosteopathy" by him, as well as the AP-complex reported by the same author. The Ap-complex in football players is a combination of insertionitis of the adductors of femur, myofascitis with insertionitis of musculus rectus abdominis, and the symphysis changes included in the syndrome. The cases with partial tendinitis of the prepatellar tendom with degenerative changes and microruptures of some of its fascicles, turning them into a hard cord situated alongside the tendon itself from apex patellae to tuberosites tibie are also assigned to this group. The lesion is most frequent in high jumpers, volleyball players and weight-lifters.

Fig. 5 gives some data about the incidence of the different athletic microtraumata, using the classification accepted by us. Most frequent are the insertionites (23.9%) and the arthroses (22.7%), then come the tendovaginites, the tendinites (17.2%), the third place is occupied by the chondrodystrophies, radiculites and plexites (0.2%), the fourth by the myogeloses (5.7%) and the periarthrites (5.2%), and finally come the periostoses (2.9%) and the chronic bursites (2.2%).

At the end of our survey we will discuss some sports-medical problems of prophylactic importance for the development of morbid and premorbid conditions as the result of hard training.

First of all, measures are to be taken to render hard work loads optimal and to increase the training effect. It hardly seems expedient to use the term "maximum loading" which has gained a certain popularity. It is true that the higher the physical stress, the greater the adaptation changes and training effect. But it is like that only up to a certain optimal limit. Going beyond this limit leads to an exhaustion of the functional reserves of the organism, to failing adaptation and to pathological conditions. This requires looking for means which might supply us with precise objective and urgent information as soon as this safe risk limit is reached. It is a matter of tests that would enable us to increase the training effect without unreasonable increase in the training stress.

Reference is made not only to the improved methods of training, but also to the proper hygiena regimen (sleep, avoiding unhealthy conditions of life, such as smoking and alcohol), training massage, proper nutrition, the use of biological substances enhancing the capacity for work and the adaptation possibilities of the organism.

The possibilities offered by the cross adaptation for increasing the training effect (Nassonov, Yakovlev) are noteworthy. It has been established that the effect of various strongly acting agents produce similar biochemical changes in the organism. Therefore a systematic training with one factor causes also an adaptation to another factor.

For instance, intensive muscular activity leads to an increased adaptation to the influence of thermal factor (low and high temperature), and vice versa. Hypoxic training increases the training effect of muscle training etc. Thus after proper application of the thermal factor and hypoxic training, it is presumed that the training effect could be considerably increased. However, it would be expedient to use this possibility mainly in athletic events where the capacity for work is limited by metabolic changes.

The second important problem is to secure optimal regulation of correlations within the system "training - recovery". Restoration processes are directly influenced by the bulk, intensity and nature of training itself. The training with high work loads leads to improvement of the recovery processes. As well known (Engelhard, Yakovlev) the greater the intensity of metabolic processes during intensive efforts, and the higher the amount of metabolites obtained as result of this metabolism, the more intensive the recovery, the quicker and better pronounced the phase of overcompensation.

It is known that recovery processes are characterized by phases and heterogeneity. The cyclic nature of the restoration processes is typical not only with the appearance of the phase of overcompensation which is virtually an aftereffect of the training, but also with a certain regularity in recovery stages (current, urgent, lagging behind and recovery after chronic overstrain - Volkov, Giplenreiter, Vassilev). While the current recovery is decisive for the determination of training methods, the urgent recovery is related to the planning of the training program, and the recovery which is lagging behind is related to the planning and methods of carrying out microcycles.

Being aware of the heterogenous nature of recovery processes is likewise essential. During athletic training for various events, the individual systems are loaded to a varying degree. Determining the limiting system for each sport or group of sports allows an expedient recovery, the limiting system being actively, completely and rapidly restored.

In other words, recovery is not a passive process. It is an active process and it should be actively aided.

The methods of applying different recovery methods requires special treatment, the essential thing being to restore the equilibrium of the system "training-recovery" which has been upset by hard training and to maintain the training effect achieved and the health of the athlete.

In conclusion, it should be underlined that the basic task of the sports doctor is to estimate the "cost that is paid" by the athlete's organism in hard training, and to try his best and by all means to lower this cost to the extent that it would be compensated for by the adaptive structural and functional changes taking place in the organism.

ELECTROCARDIOGRAPHIC EXAMINATION OF SOCCER PLAYERS AFTER MAXIMUM PHYSICAL EXERTION ON VELOERGOMETER

V.Velev - Bulgaria

Electrocardiography is a basic and most frequently applied objective method in the complex functional examination of athletes for their heart state assay. But the electrocardiogram made at rest /ECG/ only is not in a position to give us a complete idea of the functional state of the myocardium, and hardly contributes to the early diagnosis of some prepathological and pathological variations. At present, the method of ECG examination is often used after various physical efforts both in the clinical practice and in sports medicine. In laboratory conditions during functional examination of athletes, electrocardiography after maximum physical charge is used too, usually within the framework of the spiroergometric study.

It is the purpose of this study to analyze some basic ECG components in soccer players by means of a continuing monitoring in the recovery process after maximum stress in order to elucidate more comprehensively the functional state of the heart.

METHOD

The ECG of 83 soccer players from the National Football League aged 18-35 years, most of them having a long athletic training history have been analyzed. The ECG examinations were carried out always in the morning before meal, in lying position, at rest and after maximum physical stress on the veloergometer. The work load was increased gradually and stepwise in combination with the spiroergometric examination. We worked with directly registering electrocardiograph "Hellige" - simpliscriptor EK - 75 with a speed of 50 mm/sec and adjustment 1 millivot = 10 mm. The football players were instructed to reach a maximum pulse rate above 180/min. At rest we registered ECG in the three standard and three intensified unipolar leads from the extremities, and in the unipolar chest leads V_2 and V_5. We observed the ECG at the beginning of the first minute /till 30 seconds/, on the third, fifth and seventh minute of the recovery period.

RESULTS AND DISCUSSION

FREQUENCY OF HEART CONTRACTIONS. Most of the athletes show a heart rate of 40-80% above the initial on the 7th minute of the recovery.

The sinus arrhythmia often existing at rest disappears after the maximum effort by the end of the recovery period.

ATRIO-VENTRICULAR CONDUCTION - P-Q interval. At rest it is on the average 0.16 sec., i.e. within normal physiological limits. Most frequently the interval P-Q is of 0.16-0.18 sec /49.4%/ and of 0.12-0.15 sec /36.1%/. Less often it is of 0.19-0.21 sec /14.5%/ and only in 4.8% above 0.21 sec.

In the first minute of the recovery period, the interval P-Q shortens with 0.02 sec. on the average. In most of the players under study the time of the atrio-ventricular conduction shortens a little /0.01-0.02 sec/ or remains unchanged immediately after the exercise. The prolongation of the interval P-Q above the initial values has been observed rarely and in small deviation /0.01-0.2 sec/. Its greater prolongation is considered as a sign of poor functional state of the heart and can be observed in athletes with too little or too much training /L.A.Butchenko,1968/. A more considerable shortening of the interval P-Q /with 0.04 and more/ was most frequently observed in cases with high initial values of the Conduction time and with a higher heart rate.

The recovery of the interval P-Q usually occurs yet on the 3rd minute. 66.2% of the football players recover on the 3rd, 13.2% - on the 5th and 6% - on the 7th minute. Only 14.4% of the examined fail to recover completely by the 7th minute, with a difference from 0.01-0.03 sec.

Often, after the initial shortening of the interval P-Q, some prolongation is observed above its rest values, and at the end of the recovery period - once again a shortening. Such a prolongation with 0.01-0.02 sec was observed in 27.7% of the players, with 0.03-0.04 sec in 12% and above 0.04 sec - in 2.4% which is probably due to some phase evolution of the vegetative reactions.

ELECTRIC SYSTOLE /interval Q-T/. The observed value of the interval Q-T at rest is 0.40 sec on the average. As compared with the physiological norms, calculated according to Hegglin and Holzmann, with a few exceptions the differences do not exceed 0.04 sec. On the first minute after exercise, the interval Q-T deviates a little up to ±0.02 sec/ from the theoretical values of the corresponding pulse rate in about 70% of the cases. The prolongation of the Q-T interval with more than 0.04 sec. relative to the corresponding norm was observed only in 7.2% of the football players. A similar lengthening of the electric systole is considered as a sign of unsatisfactory functional state of the heart /Butchenko,1968;

Letunov, 1954; Reindell, 1949/.

Within the first minute of the recovery, the Q-T interval shows a tendency to a progressive prolongation. Thus, on the 3rd minute Q-T exceeds the normal values by more than 0.04 sec in 18% of the cases, on the 5th minute - in 24%, and on the 7th minute - in 35%. The recovery on the 7th minute is not complete.

WAVE-P. In Ist lead after maximum charge it does not change essentially. In IInd and III leads it increases, this being most pronounced on the Ist minute of the recovery, and decreases gradually, but fails to reach the initial level by the 7th minute.

The changes in the waves of the chamber complex are similar. On the Ist minute the Q_I and R_I waves decrease, and Q_2, Q_3, R_2, R_3, S_I, S_2 and S_3 increase their amplitude.

THE SUM OF R TEETH /$R_1 - R_2 - R_3$/. Immediately after the charge, most frequently it is slightly increased or unchanged /75%/. The considerable decrease and sharp increase are equally a sign of inadequate training and deteriorated functional state of the myocardium /L.A.Butchenko/. The cases with marked decrease of the R teeth sum often show additional functional deviations of the ECG after the exercise. Recovery of this parameter was recorded only in 37% of the football players. Rather often it is slightly above the initial level.

SEGMENT S - T. At rest it is usually elevated and mainly in lead II. After the charge, on the Ist minute, a decrease of the segment S-T was observed mainly in lead II and III. It occurs together with the segment P-Q and is due to tachycardia. On the 7th min. most often the segment S-T does not reach the initial level.

WAVE T. After a great physical stress the T wave undergoes characteristic changes during the recovery period. Immediately after stress, a slight decrease occurs, followed yet in the first minute by an increase, and at the fifth min. by another decrease /Reindell, 1949; Slepak, 1956; Klepzig u.Miterb.; 1956; Rosenblat u.Miterb., 1962; Butschenko,1963/. The increase in T wave after muscle work is determined probably by the oscillations of the vegetative tonus and by the changes in myocardial bioenergetics, whilst the decrease at the end of the recovery period - by blood deposition in the periphery /L.A.Butschenko,1963/.

The P wave in lead I slightly decreases after stress, and at the end of the 5th and 7th minute the decrease is more pronounced. In most cases the T wave does not change or slightly decreases /0.5-2 mm/ on the Ist minute, and increases only in 24.2%. The T wave in lead II, on the contrary - most often increases in the first minute of the recovery, and decreases only in 20.5%. In lead III its elevation is still more marked. It decreases in 6% of the cases. Both in Ist and IInd leads a lowering of the T wave below the initial values is noted on the 7th minute of the recovery - T_I - in 90% of the cases, T_2 in 61%, and T_3 - in 10.8%.

The T wave in V_2 after exercise increases and about the 7th minute reaches almost the initial level. The T wave in V_5 likewise shows a modrate increase, and on the 5th and 7th min. a lowering of T V_5 below the rest values is observed in 81% of the examined football-players. The marked decrease in T wave at the end of the recovery period is a sign of worse blood regulation and is encountered rather often in not enough trained athletes /L.A.Butschenko/. We observe this phenomenon also in players with overfatigue and overstrain of the heart.

The appearance of very high and sharp "giant" T waves after stress is also considered as a sign of poor functional state of the heart.

ELECTRIC AXIS OF QRS. In the Ist min. after maximum charge the electric axis of the heart remains unchanged or slightly deviates to the right I-9° in most competitors /47%/. Deviation to right by 10-30° is noted in 37.4%, and by more than 30° - in 6%. A leftside deviation of the electric axis is encountered less frequently /6%/ and is usually moderately pronounced /1-9°/. A 10° deviation to the left is observed only in 3.6%. The great deviation of the electric axis of the heart both to the right and to the left is regarded as sign of a poor functional state of the heart /L.A.Butschenko/.

ELECTRIC AXIS OF T WAVE. After physical exercise, the electric axis of T wave is found deviated to the right by 18° on the average. It is without alteration and rithside shift by 1-9° in 23%; from 10-29° - in 44.5%; from 30-50° - in 13.2% and above 50° - in 8.4%.of the football players. Deviation of the electric axis of T wave to the left is encountered less frequently: from 1-9° in 7.2% and from 10-30° in 3.6%. It suggests an unsatisfactory functional state of the myocardium, especially when its direction differs from the electric axis of QRS.

In most football players under study the electric axes of QRS and T are shifted in a single direction after stress. Only in 13.2% the shift is in various directions. In the Ist minute after the maximum effort the difference between the electric axes of QRS and T decreases and at the end of the recovery period it is close to the initial one. Considerable increase of the difference between the electric axes after load is characteristic of the smaller functional capacity of the heart /Tischler, 1953; Shulyateva, 1959/.

CONCLUSIONS

After maximum physical effort on veloergometer, the following important ECG alterations were observed in football players:

1. The heart rate on the 7th min. of the recovery period exceeds by 40-80% the initial one.

2. The time of atrio-ventricular conduction most often shortens moderately /0.01-0.02 sec/ or remains unaltered, and it recovers in most athletes within 3 minutes.

3. The electrical systole as compared with the physiological norm, with a few exceptions, does not exceed 0.04 sec.

4. The waves P_2, P_3 and Q_2, Q_3, R_2, R_3, S_1, S_2 and S_3 increase their amplitudes.

5. The sum of the amplitude of R waves from the standard leads is slightly augmented or unaltered in 75% of the cases.

6. The S-T segment shows a lowering under the isoelectric line together with the segment P-Q mainly in 2nd and 3rd leads, and usually does not reach the initial level at the end of the recovery period.

7. T wave in most cases increases in 2nd and 3rd lead. A slight lowering mainly of the T_1, T_2 and T V_5 waves is observed at the end of the recovery.

8. The electric QRS axis and T deviate most often undirectionally, moderately to the right, with shortening of their angle difference.

In most football players under study, the changes in ECG after physical stress show a good functional state of the heart. The continued tracing of the values of some ECG parameters after maximum physical exertion is a valuable additional method in the complex examination of athletes which gives us information on prepathological and pathological variations in the cardio-vascular system.

FUNCTIONAL SPECIFICITY OF THE CARDIOVASCULAR SYSTEM IN ACTIVE EX-ATHLETES

B.Milenovitch, D.Yovanovitch, R.Djurashkovitch

Thanks to the close contacts between ex-athletes and the Dispensary of Sports Medicine, and to the Section of rehabilitation of cardiovascular patients in the same Dispensary, it was proposed to investigate the state of the cardiovascular system in ex-athletes. We have been prompted to this more particularly by the fact that in the Rehabilitation section there were many persons with serious changes in the heart who have been actively engaged in sports in the past. Literature reports on this subject are rather scarce, and therefore our study acquires a still greater importance.

MATERIAL AND METHOD OF WORK

30 ex-athletes were included in the research, ranging from 41 to 61 years of age /X = 57/ and sports practice length from 6 to 17 years / x = 13/. They have ceased athletic activities before 22 years on the average. All of them were healthy while having been engaged in sports. Most of them have trained and competed under the supervision of coaches, and only a small number have undergone medical control. Most of them have ceased abruptly all athletic activities, and only three have participated in sports organization from time to time.

ECG was recorded in 12 usual leads in basic conditions after 10 minutes bed rest in the out-patient department, using electrocardiograph type 100 "Hellig" EI-Nish. The electrocardiographic band moved at a speed of 25 mm/sed. ECG changes analysis comprises: frequency of the heart activity, duration of PQ and QT intervals and the appearance of some ECG accidents. All results have been statistically analysed and thus presented.

RESULTS AND DISCUSSION

The ECG analysis in ex-athletes shows changes pointing to ischemia and degeneration of the myocardium in 33% of the cases, i.e. in 10 out of the total of 30 examined persons. 8 of them had changes following myocardial infarction and 2 - ischemic changes. In 4 individual the infarction was not accompanied by other cardio-vascular changes. It is a matter of infarctions sustained in the past, and no recent signs can be detected in the tracing. The ECG is satisfactory since the patients undergo rehabilitation in the dispensary. The other 4 infarctions have marked concomitant essential hypertension and signs of ischemia (negative in I, aVI, V_5 and V_6, and flat in II and aVF).

Of the two cases with marked ischemic ECG changes, the one shown in fig. 3 is noteworthy. This is the ECG of an outstanding ex-athlete who changed often the teams during his athletic career, and therefore he was subjected often to medical control. He was never told of having had ECG changes. 17 years ago he stopped suddenly his athletic activities without any heart or easy fatigability complaints, and was invariably with normal pressure. Two years ago he took part in a jubilee match for ex-football players without any complications. After the meet, the ECG taken in the dispensary revealed ischemic changes. /T negative in II, III, V_3, V_4, V_5 and V_6/. Because of discrepancy between the subjective feelings and the objective results, the individual was tested on ergometer with a load of 100 W/60 rpm for 5 minutes, and the ECG control was repeated. It is evident that the T-wave alters essentially its aspect in V_3, V_4 and V_5, while the ST segment is shifted from the isoelectric line more pronounced in II, V_5 and V_6. After this examination the ex-athlete underwent treatment in the rehabilitation