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RESEARCH ARTICLE

STUDY ON THE ROLE OF SURFACE EMG BASED SUPEROXIDE DISMUTASE COMBINED WITH PRESSING KNEADING IN THE EXERCISE FATIGUE OF SOCCER PLAYERS

Bin Zhang*, Lei Cao

Shijiazhuang University of Applied Technology, Shijiazhuang, 050081, China
Corresponding Author Email: irekhoreot_funaab@protonmail.com

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ABSTRACT

In the present study, the author researched on the role of surface EMG based superoxide dismutase combined with pressing kneading in the exercise fatigue of soccer players. To observe the therapeutic effect of pressing and kneading manipulations for exercise fatigue of the anterior tibia muscle, sixty healthy subjects were randomly divided into two groups, 30 in each group. The test training was employed to induce left anterior tibia muscle fatigue. After this, subjects in the observation group received 5 min of tuna treatment, while subjects in the control group just lay down for 5 min. Then the integral EMG electricity, maximum amplitude, mean frequency and slope of the anterior tibia muscle and gastrocnemius muscle were measured using a surface electromyography (EMG) during the passive movements of the ankle joints in two groups. Rest and superoxide dismutase can both improve muscle fatigue. Superoxide dismutase can obtain a better effect within the same time frame.

KEYWORDS

superoxide, anterior tibia muscle, electromyography

1. INTRODUCTION

In the present study, the author researched on the role of surface EMG based superoxide dismutase combined with pressing kneading in the exercise fatigue of soccer players. Fatigue is the result of the combined effects by multiple factors. The status of fatigue, drowsiness, weakness, headache, insomnia, etc. which resulted from long time exercise motional labour usually belongs to physiological fatigue, and is thought to be protective signals issued by the body. These phenomena don't hurt the body and can be restored through rest and recuperation (Li et al., 2008). However, over-fatigue caused of the accumulation of fatigue can affect the function of the body and cause organ lesions that have serious harm to human health. Fatigue crowd is expanding with compact social rhythm, busy work and life. Moreover, for special populations such as athletes with frequent high intensity training, workers under hypoxia, high temperature, and high humidity environment as well as closed environment for long time, officers accepting long-term military training and so on, fatigue continue to produce but can't recover in time resulting in accumulation, which caused great damage. Therefore, to find effective drugs to delay the occurrence of fatigue or quickly eliminate fatigue are of great significance for social medicine, sports medicine, and military medicine. At present, the clinical medicine for fatigue is mostly chemical drug with the function of being excited central. These drugs have a significant effect, but also have large side effects especially for the central nervous system, and most have addiction and dependence (Sevag et al., 1938).

In the last decade, extensive research has been conducted at home and abroad on gingko leaf extract regarding its chemical composition, pharmacological action and clinical medicine, and has obtained many results. These studies indicate that gingko leaf extract is rich in effective ingredients such as flavone-type active sub stances and lactone, possesses multiple functions by dilating blood vessels, improving vascular function and blood circulation and metabolism, eliminating free radicals, protecting organism tissues and increasing resistance to hypoxia, without exerting any side effects on the animal or human body. It has especially remarkable effects on the prevention and treatment of hypertension and heart diseases. However, related research on athletic health protection as well as its function in anti-athletic fatigue and the improvement of athletic ability of animal or human body is less available. Hoping to seek the practical solutions for motor training, the authors were to probe into the effects of gingko leaf extract on rat endurance and anti-fatigue capability, aiming to provide basis for developing new athletic tonic as well as further studies on the effects of gingko leaf extract on athletic capability (Tan et al., 2012; Ray et al., 2013).

2. OVERVIEW

Superoxide dismutase (SOD) was a type of enzyme that has metal ion and was found by American scientists Mccord and Fridovich in 1969 from ox red blood cells, which was also the only enzyme whose substrate is free radical. It takes an important part in keep the balance of body's free radicals creation and clearance for he can clear $O2^{\cdot-}$ in the body. At present, many aspects of superoxide dismutase (SOD) have been reported and there were about 100 SOD genes have been cloned and sequenced. Furthermore, many studies of SOD will be reported since then. Comparing the reported SOD genes, we found that there were not entirely same genes so far. By way of medicine there are SOD products in America, Germany and some other countries but not in china. Moreover, there are a little of

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SOD in animals, plants and microorganisms, so the technology of isolation and purification of SOD is complicated. However, by means of gene engineering, the SOD products have been effectually produced. Anyway, scientists are attempting to express diverse exogenous genes by the system of BMNP in the laboratory of many universities and academic institutions (Lin et al., 2014; Sohn et al., 2014; Riemer et al., 2014).

Thus, most of the research attention about fatigue crack growth has been focused on the crack propagation speed before the crack reaches the critical failure length. The stress intensity factor ranges at a crack tip are proposed by Paris as governing parameters for fatigue crack growth rate in 1961. This landmark development established the theoretical basis for estimation of damage tolerance and fatigue life of engineering structures. However, series of experimental investigations in the past few decades have shown that the linear-elastic-fracture based Paris law is not capable of describing the fatigue crack propagating processes that dependents on the shape, size and the stress distributions of the plastic zone, such as the effects of load ratio, overload retardation, the transverse stress on biaxial fatigue as well as the propagation of physically short crack emanating from notch root.

People have recognized that the crack-tip plastic zone plays an important role in fatigue crack growth, and devote tremendous effort to introduce plastic zone as a mechanical parameter of fatigue failure criterion. However, the variation of the shape, size and stress distributions in the crack-tip plastic zone, which are loading history dependent, are extremely complex under variable cyclic loading conditions (Probst et al., 2015). The analytic models and mechanical parameters developed during past few decades are not sufficient to describe the property of crack-tip plastic zone. These models are not capable of interpreting the intrinsic relationship between fatigue crack growth behaviour and crack-tip plastic deformation. Therefore, how to describe the effect of the crack-tip plastic deformation on the fatigue crack growth behaviour is one of the most concerned projects that have not been fully addressed yet. Recently, our research group has developed an approximate solution for the effect of crack-tip plastic deformation on stress intensity factor based on Esher by equivalent inclusion theory and transformation toughening theory. The solution provides rigorous and effective analysis methods to reveal the effects of the crack-tip plastic zone for fatigue crack growth behaviour in the metal materials (Shamsaei et al., 2014; Pidaparti et al., 2015).

Fatigue is a very complicated problem for the structure and machinery. And fatigue researches contain a quantity of empirical laws and contradictory views. There are many influencing factors on fatigue strength and fatigue life. At present, most influencing factors can't quantitatively describe fatigue phenomenon with physical models or mathematical models. And there are big differences between test conditions and practical applications. Although a lot of theory results and test data have been obtained, accurate prediction and analysis for the fatigue strength and fatigue life can't realized better. One hand, fatigue destroy can be prevented efficiently with fatigue research results and taking related measures in actual engineering application. On the other hand, though the same principles guide the same applications, fatigue destroy accidents still can't be prevented. All facts show that fatigue problem still can't be solved completely on theories and practice. With the more requirements of rapid development diversity in society, fatigue more and more has been an important problem on academic circles and industry circles in home and abroad. The paper mainly studies the fatigue problem of the engineering machinery members. The engineering machinery is one of important tools in the human society application. With the development of modern science technology, more and more high demands are put forward for the engineering machinery. Not only high bearing capacity is demanded in order to decrease the material use, but also long fatigue life is requested for structure. The researches of machinery strength valuation, design and fatigue life estimation are paid more attention and developed. When the researches are done with the existing theories, the shape characteristics and case environments of machinery members become important influencing factors. Besides, calculation steps and use methods are also very different (Iacoviello et al., 2015).

3. Materials and Methods

Exercise fatigue in anterior tibia muscle is often seen in those who just started physical exercise. Without prompt rest and management, the fatigue may further result in stress injury, known as tibia and fibular fatigue periods, which may, in turn, lead to loosened periosteal, sub periosteal haemorrhage, subsequent swelling or pain and possibly tibia periods of the lower leg. This condition can occur in any age group; however, it is most commonly seen in people aged from 20 to 40 (taking up approximately 800Io). According to the clinical reports, the incidence of anterior tibia muscle fatigue is on the rise year by year. Using the surface EMG test, the authors of this article evaluated the therapeutic effect of pressing-kneading manipulation for exercise fatigue of the anterior tibia induced by isokinetic muscle strength.

"Physical" is originally translated from "physical fitness". Broadly speaking, it refers to the athletes' necessary integrated embodiment of all kinds of sports abilities, in order to improve the level of soccer sports skill, tactics and create excellent performance in the game. In a narrow sense, soccer physical means that soccer athletes' maximum mobilization of organism function ability for its ability to fight the body fatigue in training and competition. To some extent, this ability is Sandi's special endurance, or physical strength. Physical strength is an important part of the fight against ability and also the basis of technical and tactical training. As a direct antagonism project with great strength, high density continuous attack and defines, soccer puts forward very high requirements on the athletes' physical. According to soccer Competition Rules, domestic and abroad soccer competition (except commercial and team competitions) are adopted two out of three sets. Win the first two rounds (dominant victory except) win the game, with net for two minutes, rest a minute.

In this competitive project of high strength and density tonal adversarial attack and defines, athletes should be properly analyses the opponent's physical condition, and carry out a reasonable allocation to achieve lasting anti-war purposes, and ultimately win the game. In recent years, many athletes at the start of the game ferocious attack just like a lively dragon and an active tiger in national soccer competitions. However, after two, especially in the third round, physical strength drops obviously, some athletes even lose defensive strength.

There are so many examples which illustrate how important that athletes' physical distribution is. Some athletes' distribution of is Cop-out. They simply take attack without analyzing their opponent's tactics or physical strength, and also neglect their own physical condition. So, that they are likely to lose. To solve this problem, we have to combine technical characteristics and project requirements of soccer, and attach importance to the physical quality training so as to improve the athlete's physical strength. Only in this way can we enhance the overall competitiveness and compete at a high level in a leading position.

Subjects were recruited by advertisements at Beijing Sport University. They underwent a screening procedure including medical history taking, measurement of bodyweight and height. Eight male Sandal athletes were selected on the basis of being in good health, non-diabetic, non-smoker, no vegetarian, using oral contraceptives, not using other medication, not spending more than 3h sport activities a week and at most moderate alcohol users (<10 alcoholic consumptions per week). Only male Sandal athletes were included, because in previous studies it was found that men responded more consistently and with a greater increase in GH after ingestion of certain amino acids (AAs) than women. Their mean age was 21±1.5 years, and their body mass index was 28±1.8 kg/m2. All tests were performed in the early follicular phase of each male Sandal athlete's menstrual cycle, to eliminate the confounding variable of changing serum estrogenic concentrations. The Medical Ethics Committee of Maastricht University approved the study protocol and all subjects gave their written informed consent before participating in the study.

3.1 Materials

Sixty healthy subjects aged from 20 to 55 (from the Shanghai Hua Xia Health Massage Training School) were randomly allocated into two groups, 30 in each group. Of 30 in the observation group, there were 19 males and 11 females, aged from 22 to 53, with an average age of (41.68116.76). Of 30 in the control group, there were 18 males and 12 females, aged from 25 to 50, with an average of (36.74114.76). There were no statistical differences between the two groups. Using the Biodex System-3 poly point isokinetic test instrument, the anterior tibia muscle fatigue of the left lower limbs was induced. The modelling procedures are described as follows: Preparation: To educate the subjects to understand the basic methods and principles of isokinetic muscle test and conduct 2

times of sub state flexion and extension of the ankle joints. Setting up files for the subjects: Enter the essential information of the subjects including names into the isokinetic muscle strength evaluation/training system. Select test protocols: Limit the isokinetic exercise speed as 600/s and a 5 min interval between two tests. Immobilize the subjects: Immobilize the left ankle joints to the dynamic axis of the isokinetic muscle strength test instrument and the torso and left thigh to the test chair. Ask the subjects to grasp the bilateral handles of the chair. Adjust the height and A-P position of the chair to enable the subjects' external condyle of the femur to align with the rotation axis of the unit head. Then adjust the length of the force arm and tie up the upper part of the ankle joint to the head-end of the force arm to be measured. Test: Set the ankle joint range of motion and weigh the left lower limb. Revise the obtained data by the measured weight of the lower limb to exclude the gravity during exercise. Then click to start and ask the subjects to conduct dorsal extension of the power arm to the full range of joint motion and then flex the ankle joint to the original position. Repeat this procedure 50 times to induce anterior tibia muscle fatigue. Simultaneously, collect and record the mechanical signals of muscle contraction.

During the test, employ wireless remote sensing surface EMG to measure the synchronized myoelectric signal of the anterior tibia muscle. End: Unloosen the subjects. In total, it conducts twice modelling tests, once before treatment (during modelling), and once after treatment (Fig 1). After finishing the first modelling, conduct 5-minute pressing kneading treatment: Apply 5 min An-pressing and Rou-kneading to the left anterior tibia muscle, focusing on Yanglingquan (GB 34), Zusanli (ST 36), Shangjuxu (ST 37) and Fenglong (ST 40) (Figure2). After finishing the first modelling, ask the subjects to lie down for 5 min (Figure 3). Myoelectric signals refer to the compound muscle action potentials recorded by electrodes, often using markers that are closely associated with the fatigue degree, including integral myo-electricity, maximum amplitude, mean frequency and slope. In addition, observe the differences of surface myoelectric signals, known as gain or gain rates, which can objectively reflect the muscle status Steps of measuring myoelectric signals (Figure4): Setting up files of the subjects: Enter the essential information of the subjects including names into the Telemy 2400 Wireless Remote Sensing Surface EMCx Stick the electrodes: Rub the keratoderma of the left anterior tibial muscle (to be placed electrodes) using skin emery paper and clean with 75% alcoholic cotton ball. Immobilize the surface electrodes to the lead wire. Then, stick the surface electrodes to the test area along the running course of the muscle fibres. Place the reference electrodes over the tibia tuberosity. Test: Conduct the test following the selected protocols. Collect the synchronized myoelectric signals using the surface EMG and send to the laptop software via a wireless emitter. Perform twice tests, once during modelling and once after pressing kneading or rest. Ask the subjects to repeat flexion and extension of the ankle joints 50 times and re-collect the synchronized myoelectric signals. Use SPSS 13.0 version software for statistics, (x幼 for data expression in each group, and t-test for quantitative data that correspond with normal distribution and Wilcoxon Rank Test for data that do not correspond with normal distribution. $P<0.05$ indicates a statistical differences and $P<0.01$ indicates a marked difference. Figure4. Surface EMG test analysis of two groups before treatment Before treatment, the integral myoelectricity, maximum amplitude, mean frequency and slope of the anterior tibia muscle during exercise in two groups were consistent under isokinetic mode ($P>0.05$). After 5 min pressing kneading or rest, the maximum amplitude, mean frequency and slope in two groups all decreased. Subjects in the observation group obtained a markedly increase than the control group in integral myoelectric (IM) gain and gain rate, maximum amplitude (MA) gain and gain rates, mean frequency (MF) gain and gain rates as well as slope gain (SG) and gain rates ($P<0.05$). This indicates that the myoelectric signals were not fully recovered, but pressing kneading has better effect than rest on improving the myoelectric signal of the anterior tibia, especially within a short time period (Figure 5, 6).

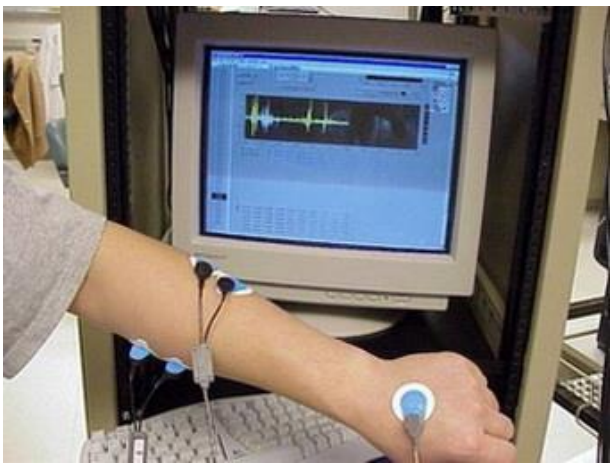

Figure 1: EMG figure

Figure 2: Treatment

Figure 3: Rest

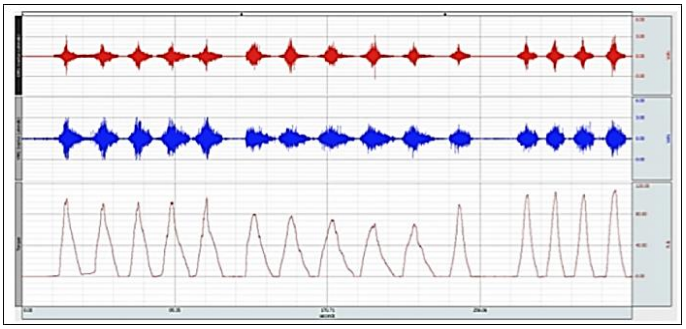

Figure 4: Determination of the myoelectric signals

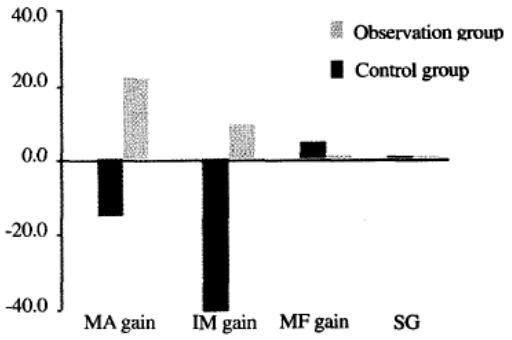

Figure 5: Comparison of myoelectric gains between two groups

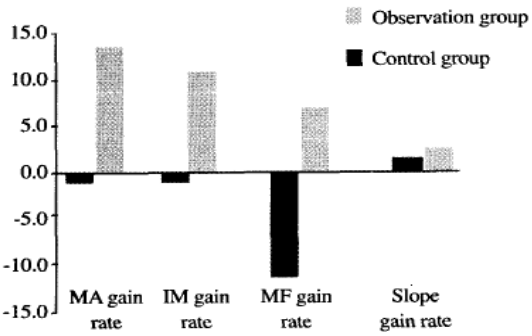

Figure 6: Comparison of myoelectric gain rates between two groups

3.2 Descriptive statistics

During the first 3 weeks of low load training, all rats in training control group and administration training group could complete the designed training tasks, but in the fourth week, the training scheme could be completed without breaks in the 6-day training by (83.34+10.45) % rats in training control group and (94.45+4.3) % rates in administration training group. The rat number dropped to (79.1716.97) % and (88.9516.75) % in the fifth week, suggesting that some of the animals displayed reduced load-bearing capacity with the increase of training load and were unable to complete the training plan without breaks. From the results, we found that the athletic capability of rats in administration training group was slightly stronger than that in training control group, which might be related to assistant function of gingko leaf extract.

3.3 Algorithm

S_{HM} solution vectors are randomly generated according to the variable range for each variable [15]. Namely,

$$HMV = \left[\begin{array}{c|c} \boldsymbol{x}^1 & f(\boldsymbol{x}^1) \\ \boldsymbol{x}^2 & f(\boldsymbol{x}^2) \\ \vdots & \vdots \\ \boldsymbol{x}^{S_{HM}} & f(\boldsymbol{x}^{S_{HM}}) \end{array}\right] = \left[\begin{array}{cccc|c} x_1^1 & x_2^1 & \cdots & x_N^1 & f(\boldsymbol{x}^1) \\ x_1^2 & x_2^2 & \cdots & x_N^2 & f(\boldsymbol{x}^2) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_1^{S_{HM}} & x_2^{S_{HM}} & \cdots & x_N^{S_{HM}} & f(\boldsymbol{x}^{S_{HM}}) \end{array}\right] \quad (1)$$

Hence, we have equation (2):

$$x_i^{new} = \begin{cases} x_i^j, \ j \in \{1,2,\ldots,S_{HM}\}, \ if \ \ rand < HMCR \\ \overline{x}_i \in X_i, \ otherwise \end{cases} \quad (2)$$

As for x_i^{new} from harmony memory, we have equation (3):

$$x_i^{new} = \begin{cases} x_i^{new} + rand * BW, & if \ \ rand < PAR(\text{Continuous}) \\ (k+\lambda) * x_i^{new}, \lambda \in [-1,1], & if \ \ rand < PAR(\text{Discrete}) \\ x_i^{new}, & otherwise \end{cases} \quad (3)$$

The worst harmony is replaced with the new harmony, i.e.,

$$\boldsymbol{x}^{worst} = \boldsymbol{x}^{new}, \ if \ \ f(\boldsymbol{x}^{new}) < f(\boldsymbol{x}^{worst}) \quad (4)$$

According to the analysis and description of routing problem in express delivery, the constraints can be expressed as:

(1) Distribution route length does not exceed the maximum value, i.e.,

$$\sum_{k=1}^{n} d(k-1,k) + d(n,0) \le MD \quad (5)$$

(2) The mathematical model of route programming can be defined as

$$L = \min\left(\sum_{k=1}^{n} d(k-1,k) + d(n,0)\right) \quad (6)$$

Based on the gradient descent method, node center and base width parameter are:

$$w_j(k) = w_j(k-1) + \eta\left(y(k) - y_m(k)\right)h_j + \alpha\left(w_j(k-1) - w_j(k-2)\right) \quad (7)$$

$$\Delta b_j = \left(y(k) - y_m(k)\right) w_j h_j \left(\frac{\left\|X - C_j\right\|^2}{b_j^3}\right) \quad (8)$$

$$b_j(k) = b_j(k-1) + \eta \Delta b_j + \alpha\left(b_j(k-1) - b_j(k-2)\right) \quad (9)$$

$$\Delta c_{j,i} = \left(y(k) - y_m(k)\right) w_j \frac{x_j - c_{j,i}}{b_j^2} \quad (10)$$

4. RESULT

12 healthy people (6 male 6 female) were chosen for the study. In the process of the test, the tester ran 1200M in the standard sporting runway at the average speed of 4-6 km/h. The canine blood biochemistry indexes (red blood cell, white blood cell, hemoglobin, total plasma protein, albumin, blood lactic acid, carbohydrate, urea nitrogen, blood create time, etc.) were examined under the peaceful condition and in 10rain, 1h, 2h and 4h after the movement, and the pulse, the body temperature, the breath rate and the 3 vain salivating quantity were determined simultaneously. According to the basic project defined in Functional Assessment Procedure and Test Methods of Health Food, which was issued by Chinese Sanitary Department, the rat loaded swimming was used to assess the anti-fatigue effect in this study. The L-Carnation, the Gamine, the create time, Fructose-1,6-Diphosphate, ginseng, taurine as well as trace elements and vitamins were chosen as the raw material. The orthogonal test design method was employed in this study. The results demonstrated that the Ghtamine, Fructose-1,6-Diphosphate and ginseng could greatly influenced on the swimming endurance, and the L-Carnitine, the create time, taurine had a little influence on the swimming endurance. Therefore, the formula A1B2C2D2E2F2 was designed and applied to the test. The results revealed that the ability of mouse anti-fatigue, the anti-oxygen deficit, heat and cold resistant in the experiment group surpassed that of the comparison group. After tester's exercising, the mainly physiological indexes had changed. The change of the breath rate and the salivating quantity was prominent ($P<0.05$), and the body temperature change was not remarkable. The blood biochemistry indexes also varied with the moving process. The quantity of red blood cell, white blood cell and hemoglobin elevated a little, the change of blood lactic acid and carbohydrate ion was remarkable, the concentration of blood lactic acid increased and that of carbohydrate ion decreased correspondingly. The blood glucose and lactic dehydrogenase also changed in the process of movement and the fatigue restoration.

Therefore, the breath rate, the salivating quantity, the blood lactic, the carbohydrate ion, the blood glucose and the lactic dchydrogcnasc could be used as the indexes to evaluate the degree of tester's movement and fatigue restoration. Canine anti-fatigue functional food additive capsules were manufactured according to the formula A1B2C2D2E2F2. 10 healthy German shepherd testers (4 male 6 female) were divided into two groups. Each group contained 2 male testers and 3 female testers. Every day only the experimental group was feed with 4 capsules, the test duration was 30 days. The body weight (limos is on the morning), the blood convention indexes (red blood cell, white blood cell, hemoglobin) and the biochemistry indexes (total protein, globulin) were tested before and after the experiment. After feeding with canine anti-fatigue functional food additive, the tester's body weight, the red blood cell and the hemoglobin had the tendency to increase. The motility ability and the work performance had been enhanced remarkably. The duration of testers' playing and searching, the fatigue coming time and distance of 8km/h obliged motion remarkably surpasses the comparison group tester ($P < 0.05$).With the respect to the mobility fatigue restoration, after the 8km/h obliged motion in jogging machine, the restoring time of tester's breath rate was shorter than that of the comparison group. 2h after the movement, the blood biochemistry indexes demonstrated that the restoring time of the blood glucose, the blood lactic acid, the carbohydrate ion and the lactic was better than that of the comparison group. But the variation of the urea nitrogen and the alkalinity phosphatase varied was not obvious. The application of this additive in 80 training testers indicated that this additive had the remarkable effect in prolonging the high intensity training time under the high temperature environment and delaying the emerging of the mobility fatigue and physical stress reaction and so on because of the long distance transportation.

(1)First stage: basic preparation (1st week). Giving priority to with strength training, the key are the breakthrough of strength and the coordination of the body.

(2)Second stage: improving ability (2-4th weeks, 3 weeks). Training is given priority to with special endurance training, mainly solving the problem of game after the process of physical deficiency, and the lack of ability.

(3)Third stage: periodic adjustment (5th week). With a relatively large intensity, the smaller amount of exercise training is given priority to, intermittent training, to maintain the special ability to decline.

(4)Fourth stage: consolidating and rise ability period (6th to 8th week, 3 weeks). Personalized training, the combination of interval training and speed training improve special ability.

(5)Fifth stage: pre-match preparations (9th weeks)

We according to the situation of recently training to carry on positive adjustments, the load and exercise should be less, avoid the fatigue caused by training, and ensure sufficient physical strength to ensure the needs of the game.

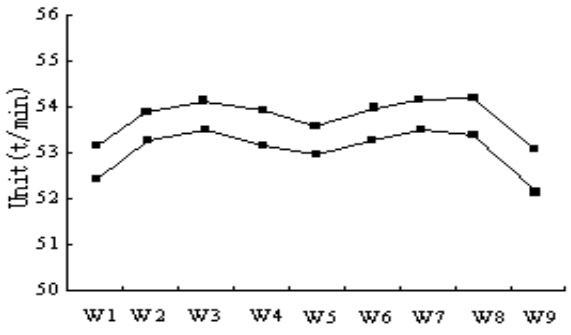

Figure 7: Mean Values of Male and Female Athletes' Morning Pulse in Different Training Phrases.

From Figure 7 we can see that the morning pulse of male and female intensity change of the fluctuations along with the amount of exercise in the whole training period, and two peaks appeared in the 4th and 8th week, but at the same time three troughs appeared in 1st, 5th, 9th weeks, and that of 9th week to reach the lowest point in the whole training period.

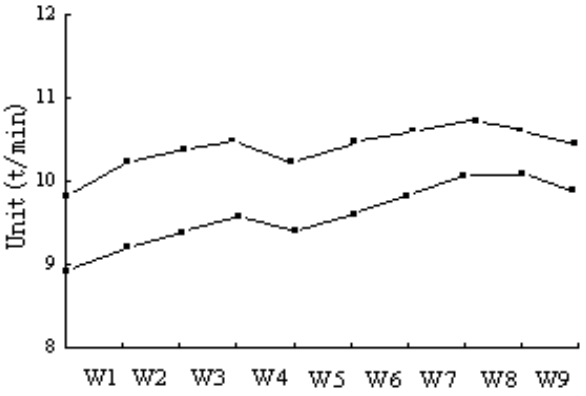

Figure 8: Mean Values of Male and Female Athletes' Diastolic Pressure in Different Training Weeks.

From Figure 8 it can be seen that the walker average diastolic blood pressure of male and female in the early morning in the whole training period, intensity change of the volatility along with the amount of exercise, and two peaks appeared in the 4th and 8th week, but at the same time three troughs appeared in 1st, 5th, 9th weeks, and that of 9th week to reach the lowest point in the whole training period.

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