The effects of different exercise training mode on interleukin

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Abstract

The author dwells on the effects of different exercise training mode on immune adjustment factor interleukin 1β (IL-1β), interleukin 2 (IL-2) and interleukin 6 (IL-6), further discusses interleukin function of immune adjustment in athletic sports. When IL-1, IL-2 and IL-6 are under the condition of body of stress, the change of blood concentration is extremely sensitive. It is clear that IL-1 and IL-6 play important roles in the occurrence mechanism of emergency and chronic inflammation, keeping physiology balance of the body at the same time. But, the studies of effects of exercise on above-mentioned index in the homeland are less and also later than stopping breaking the ice. It is still unclear about their acute phase response after sports and their peculiar effect in response of long-range endurance exercise completely, which requires a further study. [Life Science Journal. 2007; 4(3): 82 – 86] (ISSN: 1097 – 8135).

Keywords: training mode; cytokines; interleukin; immunity

1 Introduction

Due to the development and application of theory and technology in the field of molecule and cell biology, the research of exercise and immunology is going deeper. The discovery of interleukin in recent years has led to a ground breaking progress in people's understanding of the functions of immune system. In some areas people have been able to understand its working on the level of molecule. We observe the study about effects on interleukin (IL-1, IL-2, IL-6) of exercise and try to provide physiological evidence for the effect of exercise on the immune system.

2 Source and Function of Interleukin

2.1 Interleukin I (IL-1)

As glycoprotein with molecular weight 17,000, it has an effect to T cell's activation and growth and is T-helper factor for hematopoietic growth factor, which is able to cooperate colony-stimulating factors (CSF) to form large colony of high proliferative latent energy stimulating the early phase bone marrow progenitor cells. IL-1β appears much in blood circulation. It is internal secretion CK with the broad biological effect, such as fever, promoting the immune response, participating in inflammatory reaction, promoting a wound healing and stimulating the hematopoiesis function and so on.

2.2 Interleukin 2 (IL-2)

As glycoprotein with molecular weight 15,000, it has an effect to T cell's activation and growth. IL-2 produces mainly from $CD4^+$ and $CD8^+$ T cells. It brings an effect into play mainly in autocrine or paracrine way. With different kind, IL-2 has constraint upward, and has not constraint downward along kind of genealogy. For example, people's IL-2 can promote the T cell hyperplasia of a mouse, but the mouse's IL-2 cannot promote people's T cell hyperplasia. IL-2 is the important cytokine to participate in immune response, and participate in antitumorigenic effect and rejection of grafts.

2.3 Interleukin 6 (IL-6)

With molecular weight 22,000 – 30,000, called B cell

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stimulating factor (plasmocyte growth factor) in the past, it is a glycoprotein composed of 184 amino acids. Besides the terminal differentiation factor as B cell and T cell, it is newer regulated factor. IL-6 originates from mononuclear macrophages, fibroblasts, T cell and so on, whose main effects are to boost B cell hyperplasia differentiation and secreting antibody. It has a broad effect to hepatocyte, T cell, nerve tissue, hematopoietic system and also has anti-tumorigenic effect, which may strengthen NK cell activity to kill a tumour directly or indirectly. IL-6 shows its activity by the union with one kind of high affinity receptor complex. It produces from IL-1 and IL-2, and can induce synthesis of hepar acute phrase proteins whether inside or outside of the body. IL-6 can boost progenitor cells to form colony, increase the number of peripheral blood cells, red blood cells and platelets, and has the coordination effect with IL-3. Injecting experimental animals or people with IL-1 or IL-6 can produce reaction symptom[1] of acute phrase without exception. Therefore, these cytokines are called "the inflammatory cytokines" or "the inflammatory cells" generally. Besides, IL-1 and IL-6 can boost hepatocyte composing acute phrase proteins, such as C-reactive protein, a-acidity glycoprotein, serum amyloid a protein and some complement components beneficial to resist a pathogenic microorganism.

3 The Comparison of IL Level between the Athlete and Non-athlete in Rest State

The cytokines are the important bioactive polypeptides with the function of regulating cells. They are the messengers who regulate the information delivery between immunocyte. From Cannon's[2] experiment, it was observed that activity of blood plasma IL-1 for long-distance race athletes was much higher than that of non-athletes obviously in rest state. Chen Peijie reported that activity of blood plasma IL-1 for the old people who insisted on the long-distance race was higher than that of contrast group[3]. Li Xiaojun[4] also observed that "the IL-1 level is higher than that of contrast group with the same age for juvenile athletes, and difference is notable ($P < 0.05$) in rest state. While difference is not notable ($P > 0.05$) though the serum IL-6 level between the training group and contras group is different in rest state". Some scholars found that, middle or low intensity exercise training is conducive to increase IL-2 activity, while the high intensity exercise training inhibits IL-2 activity. This exactly fits in the theory of "J shape curve pattern" in the circles of sports immunology. So-called "J shape curve pattern", Niema (1994) brought forward it was shown "J" shape curve between the exercise intensity, quantity and the upper respiratory tract infection (URTI). With often and severe exercise, the function of NK cells were often inhibited severely and temporally. During immune suppression, microorganism, especially, virus invaded a host to arouse infection. But for the people who were often engaged in proper physical labor, the infection of their easy-infecting function decreased sharply, for their immunity system strengthened temporarily. The "J" shape curve indicates very clearly: different exercise arouses the different immune response and fitness. Taking upper respiratory tract infection rate for whom are not engaged in exercise in general as average value, the risk taking infection of the upper respiratory tract is much less for whom are often engaged in appropriate exercise; but the risk is much higher (7 – 20 times) for whom are engaged in high intensity and the large load of exercise training.

4 The Effects of Exercise on IL

4.1 The effects of acute exercise on IL

It was first reported by Cannon and Kluge[5] in 1983 that exercise might arouse the reaction of cytokines. There are increasing researches in this aspect in the late years. Results have a divergence since the detecting means and study models are different. Cannon's experiment was that asking subjects moving 1 hour on the bicycle dynameter with 60% VO2max intensity. He reached a conclusion that activity of blood plasma IL-1 didn't increase immediately after exercise, but elevated to 150% of rest value 3 – 6 hours later after exercise and restored to basis value 9 hours later after exercise. Another report[6] said the peak value of IL-1 was 2 – 3 hours after exercise. But later, other scholars studied and found that: the level of IL-1 and IL-6 are immediately increased after a high intensity exercise[7-9]. Some scholars discovered that: the level of IL-1 and IL-2 did not decrease before restoring to the basis line after moderate exercise; after decreasing, the level of IL-1 and IL-2 restored to the basis line at once after 3 to 6 hours of high intensity exercise; IL-2 came down obviously after 1 hour of the force exhausts sport until recovered to the level before exercise 20 hours later[10-12].

The scholars abroad thought that the level of IL-6 in blood would be rising rapidly and immediately after acute exercise, recovering to the level before exercise 24 hours later. It was also thought by some scholars abroad that IL-2 level decreased, indicating immune suppression after high acute intensity exercise[13,14]. But, Feng JY *et al*[15] found that IL-2 activity strengthened obviously in induced supernatant of murine splenic lymphocyte by

splitting primitive concanavalin A (ConA) after acute exercise. Different results may result from different exercise mode and different exercise intensity.

Guo JJ found that, the ability to secrete IL-1 for enterocoelia macrophage increased notably after high acute intensity exercise, but the creation ability of IL-6 did not change[16] obviously. Li *et al*[4] discovered that to the certain degree, IL-1 increased at once ($P < 0.05$) for all the training group after high intensity exercise; the level of IL-6 had a tendency of going up immediately after high intensity exercise. It had a notable difference ($P < 0.05$) after the 4th day's exercise till the 7th day to recover to the normal level. The research of Chen's[17] indicated that: making a 18 hours' acute swimming might lead to a increase of plasma IL-1 with remarkable difference ($P < 0.05$) and IL-6 with notable difference ($P < 0.01$) as well as a decrease of IL-2 in rats, but not significantly. The relative literature reports about effect of exercise on IL-2 concentration were not consistent in each. Most scholars thought that IL-2 was an important factor in immune regulation by experiment[18-20]. It secreted less to increase immune suppression during the period of high intensity exercise. They thought that the decrease of IL-2 might indicate the decrease of immune activating ability by lymphocyte after brief acute exercise. But Huang Chaohui discovered that, IL-2 activity that T cell secreted instantly was a little higher than the level before exercise, increased remarkably 3 hours after exercise and restored to rest value basically 24 hours later[21]. All above experiment bore fruit differently, probably because of different exercise mode and different exercise intensity or maybe because of error in experiment. Therefore, we have formed common view basically on the effect of acute exercise as well as one-time high intensity training on IL-1 and IL-6. But the studying result about influence on IL-2 has the obvious divergence; we still need to further verify both relations.

4.2 The Effect of long range training on blood plasma IL activity

It is reported by some scholars that after longtime exercise, concentration of blood plasma IL-6 increases sharply and restored to the basis level 24 hours later[22].Both Chen Peijie and Mackinnon LT reported that IL-1 activity increased after long range training[23,24]. An experiment of Feng Jianying's was to make a mouse carry out 120 minutes' non-exhaust exercise, and then they found that IL-2 activity strengthened obviously in supernatant of murine splenic lymphocyte[25]. Goldfarb and Mackinnon proved that an increase of β-endorphin could stimulate NK cell to produce IFN, promote macrophage to secrete IL-2 beneficial to NK cell to increase activity of killing the tumour[26]. Norrthoff and Ben-Yehuda[27] tested 17 marathon competitors. They found that 15 of them could be seen a notable increase of IL-6 after running. There has also been scholar studying that IL-6 secreting amounts increased obviously when doing 60 minutes' exercise with 75% VO2max intensity. They thought that the release of the IL-6 might be confined to muscle or other organ's macrophage in exercise, and put forward IL-6 was the main factor to induce exercise acute response. It might arouse exercise acute response by effect hepar. IL-6 might arouse cell loss; arouse hepatocyte secreting acute phase protein. It is an early sensitive diagnose index of septic shock in clinical medicine. From above, we can infer that over-release of the inflammatory cell during recovery after exercise may be an expression of decrease of body immune function. The coach and athletes should pay attention to the research in this aspect.

Major scholars[28,29] have studied cytokine change after 1 h 75%VO2max centripetal exercise. They found that the amounts of IL-1α, IL-1β and IL-6 produced by separated cell outside of body went up notably after exercise compared with that before exercise, while IL-2 had no obvious change. But other scholar proved[30] that it was exercise, especially centrifugal muscle exercise led to the common increase of IL-1, IL-2 and IL-6 in blood plasma and the urine liquid. The immunohistochemical method confirms that contents of inflammatory cytokines inner muscles increase after exercise of centrifugal muscle. Brunsgard[31] discovered that after 30 minutes' centripetal exercise and centrifugal exercise for the same group of healthy male athlete, four days later when the latter was engaged in centrifugal exercise, creatine kinase (CK) in blood plasma elevated 50 times higher than that before exercise, the level of blood plasma IL-6 rose by 5 times, both change indicated a logarithm relation, but the level of blood plasma CK and IL-6 did not change notably after centripetal exercise. Evant[32] reported that the exercise in which 4 male athletes and 5 non-athletes were made 45-minute centrifugal cycling exercise might induce to improve activity of blood plasma IL-1 in 1986. In all 5 non-training subjects, activity of blood plasma IL-1 could be seen to go up 3 hours after exercise, while activity of blood plasma IL-1 did not increase obviously for the training subject. The IL-1 activity of endurance athlete with high-level training was slightly higher than common people, but there was no further increase after exercise. The change of CK activity in the blood plasma between training subject and non-training subject existed notable difference. The level of CK for athlete was clearly higher than that of non-athlete before exercise, but CK of non-training subject continued elevating 5 days after exercise

whose peak value was 33 times of basis level; while the increase of blood plasma CK for training subject only has notability 24 hours after exercise. Its maximum value was only 23 times of the level before exercise. Since the increase of CK can hint the loss existed in the muscle cell, the partial inflammation response triggered by the loss can induce the IL-1 release increase. The above result shows there is an inner link between the production of CK and IL-1 activity after exercise, indicating whether we can combine IL-1 with CK as evaluating index of athlete's training level. The possible cause of this phenomenon is that the main elevating part in peripheral blood monuclear cell is $CD14^+$ monuclear cell secreting IL-1 and IL-6 during exercise. But IL-2 is mainly produced by $CD4^+$ and $CD16^+$ cell. So, there is no remarkable response for IL-2. From above, we can infer that cytokine release increases are mainly by the long-range great-quantity exercise perspires in centripetal exercise process, leading to relative blood concentration and proportion change of each cell subset in peripheral blood monuclear cell, that is, increase of monuclear cell concentration, not activation of non-monuclear macrophage.

4.3 Change of IL's activity in the periodical training

Skeletal muscles' motion is able to arouse change of body immune function. Longtime high intensity exercise (consumed oxygen exceeds 75% VO2max) can reduce number of immunocyte in body peripheral blood and immune activity of immunocyte, decreasing disease-resistant ability of organism thereby. To the change of leucocyte subpopulation of peripheral blood after exercise, at present, the comparatively consistent view is to keep training at higher than 75% VO2max of exercise intensity more than 1 hour, almost all lymphocyte sub types show decrease during recovery after training; for medium intensity training, about 50% VO2max of exercise intensity, the changes of every sub types of the leucocyte and lymphocyte roughly are not obvious. The research of Li Xiaojun's[4] the effect of high intensity periodical training on IL-1 level shows that during a high intensity training period, the IL-1 level do not have notable change; the first three weeks IL-1 has a bit rising after the tested training index is adjusted; the fourth week comes down a little, but has no notable meaning. The effect of high-intensity training period on IL-6 level indicates that no serum IL-6 changes obviously in entire training period. Longtime over- training tents to induce the contents of blood plasma IL-2 coming down[30]. IL-2 is the only cytokine reported showing decrease so far after exercise. Since IL-2 is direct mediate immunoreaction, its wide decrease may lead to body immune mechanism suppressed, causing to happen over-training disease. Whether the change of cytokine of sport immunology in training can become a sensitive index of dynamics for the change of athlete immune ability is a new subject being worth studying.

5 Conclusion

In short, analyzing from present research result, there are some inner links existed between the state of immune function and exercise. It is valuable to know the change law of immune function under the state of exercise and to know immune regulating mechanism of nervimotor endocrinosity and the physiology significance of this change. It has provided the theory basis for the explanation of some medical sport problems in training and also has laid down good physiology basis for solving the problems.

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