Effect of acute and chronic exercise in co-relation with cellular response

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Received: 8 Apr 2016; Accepted: 16 May 2016

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Abstract

A variety of research studies on experimental, clinical and epidemiological literature have demonstrated that exercise induces considerable physiological change in immune system and that it provides an opportunity to connect basic and clinical physiology and to evaluate the role of exercise stress and immune physiological mechanism. It has been suggested, that exercise represents a quantifiable model which induce a pattern of cellular immunological reactions.

Key words: Acute exercise, Chronic exercise Lymphocyte Subpopulations, Lymphocyte Proliferation, NK cells activity, Neutrophil function.

Introduction

Several research studied have been conducted to understand the acute and chronic exercise responses on blood leukocyte subpopulations. Exercise-induced cellular changes have been noted, in subsets of blood mononuclear along with a change in concentration of neutrophil and lymphocyte concentration during and after exercise (1,2).

Exercise effect on Lymphocyte subpopulations

Due to the recruitment of all lymphocyte subpopulations there is likelihood in the increase of lymphocyte concentration to the vascular compartment: CD4+ T cells, CD8+ T cells, CD19+ B cells, CD16+ Natural Killer cells, and CD56+ NK cells. During exercise, the CD4-to-CD8 ratio decreases, reflecting the greater increase in CD8+ lymphocytes than CD4+ lymphocytes. CD4+ and CD8+ cells contain both CD45RO+ memory and CD45RA and the recruitment is primarily of CD45RO+ lymphocytes (3).

Exercise effect on NK Cells

NK cells are a heterogeneous population that are CD3− and that express characteristic NK cell markers, such as CD16 and CD56. NK cells mediate non-major histocompatibility complex restricted cytotoxicity, with potential resistance to infections viral in nature and cytolysis of few malignant cells. The cytolytic activity of NK cells is enhanced by interferon (IFN)‐α and interleukin (IL)-2 (4,5). Therefore NK cells, may play an important role in the first line of defence against acute and chronic viral infections and early recognition of tumour cells & against tumor spread (6).

Various types of exercises, intensities & durations induce recruitment to the blood, showing characteristic NK cell markers. During exercise, depending on exercise intensity, the NK cell activity as per NK cell basis either remains same or reduced. During bicycle exercise NK cells with a high IL-2 response capacity were recruited to the blood. The IL-2-enhanced NK cell activity increased significantly, during the exercises more than the IFN-α-enhanced NK cell activity. This suggests that NK
cells with an elevated IL-2 response capacity are recruited to the blood during exercise. After long duration exercise e.g. Tread milling at vigorous speed and longer time duration, the NK cells concentration and cytolytic activity declines below pre-exercise values. After 2-4 h exercise, maximal reduction in concentration of NK cell is noted. However, it has also been reported that after moderate exercise, on a per NK cell basis, NK cell activity not lower down, in fact, post-exercise activity of NK cell elevated (7). Generally, activity of NK cell is elevated when measured immediately during or after both moderate & anaerobic exercise of a few minutes. The intensity, more than the exercise duration, is responsible for enhancement in the NK cells number.

**Exercise effect on Lymphocyte proliferation**

Most studies on lymphocyte proliferation have used polyclonal mitogens, which induce most or all lymphocytes of a given type to proliferate. Studies indicate that during and for up to several hours after exercise, the lymphocyte responses to the T-cell mitogens phytohemagglutinin & concanavalin A decline. This is partly due to increase in NK cells and the relatively decline CD4+ cells. In contrast after exercise, lymphocyte proliferation to the B-cell mitogens pokeweed mitogen (PWM) and lipopolysaccharide (LPS) increases or remains unchanged. In accordance with many other studies, during exercise a decrease in polyhemagglutinin response, percent CD4+ and percent CD16+ cells was observed. During exercise, the proliferation contribution of the CD4+ subgroup declined due to the reduced proportion of CD4+ cells. During exercise, more lymphocytes recruited to the blood, thus lowering responses to concanavalin A & phytohemagglutinin showed subsets decline in the percentage of T cells and proportional changes in lymphocyte(8,9).Post exercise, the total concentration of lymphocyte declines and the proliferation response is same as of pre exercise value.

**Leukocyte Recruitment**

Neutrophils movement from marginal pools located intravascularly and from extravascular storage pools contributes to exercise-related neutrophycytosis (10). The spleen may contribute to a lymphocytosis, since it is a major storage pool of lymphocytes, circulating between the blood and the splenic pulpa (11). It has been demonstrated that NK cell activity reduced by splanchnic sympathectomy (12). Splenectomized subjects demonstrate a low lymphocyte count in response to epinephrine injection (13), and during exercise subjects without a spleen show a slight increase in numbers of lymphocyte (14). However, there are also studies suggesting that the spleen does not play a role in exercise leukocytosis (15).

Based on the available data, it has been hypothesized that lymphocytes are recruited to circulation from other tissue pools during exercise. The organs involved include lymph nodes, spleen and the gastrointestinal tract. Because the cells mobilized to the blood have short telomere lengths, it is not likely that these cells are mobilized from thymus or bone marrow. The intensity of stimulus determined the number of cells, enter the circulation. If exercise e.g. aerobic / anaerobic, has been for a prolonged duration and/or of very high intensity, the total lymphocytes concentration declines. The mechanisms for this probably include the lack of mature cells that can be recruited, as well as the redistribution of lymphocytes from the circulation to organs. Therefore dependent on a combination of intensity and duration post exercise lymphopenia occurs.

**Exercise effect on Neutrophil Function**

In the total circulating leukocyte pool neutrophils represent 50–60% of population. These cells are essential for defense of host and form an innate part of immune system & are involved in the various pathological inflammatory conditions. This inflammatory involvement shows tissue peroxidation, resulting from incomplete phagocytosis. There are a several reports showing, that exercise stimulate, a series of changes in the neutrophil population. Post exercise immediate reduction in the expression of L-selectin, followed by an increase during recovery has
been reported (16). Post exercise, increased expression of the cell-adhesion molecules, may contribute to neutrophil extravasation into damaged tissue, including skeletal muscle. The neutrophil response to infection includes adherence, chemotaxis, phagocytosis, oxidative burst, and degranulation. In general, moderate exercises enhance function of neutrophil. In contrast, extreme chronic exercise decreases these functions, with the exception of chemotaxis and degranulation which are not affected (17).

Conclusion

The findings with regards to cellular response exercise have indicated towards both short and long term effects. The concentration of leukocytes, neutrophils, lymphocytes and NK cell activity depends on the intensity and the duration of rest between exercise sessions.

Acknowledgements

We are thankful to all the authors of those articles from where the literature has been reviewed for this study.

References

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