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The Effect of Anti-Inflammatory Diet on Chronic Inflammation After Resistance Training

CHAE HYUNWOO[1,*]

[1]Wuhan Chongwen High School, Wuhan, China
*Corresponding author: fdtaz@outlook.com

Abstract:

Aiming at the problems of slow recovery and persistent muscle pain in resistance training, the effect of an anti-inflammatory diet on chronic muscle inflammation after endurance training was studied. This article mainly expounds the mechanism of muscle-related inflammation after resistance training, and combined with the main and common anti-inflammatory ingredients in an anti-inflammatory diet (including polyphenols, omega-3, dietary fiber), proves the effect of an anti-inflammatory diet on chronic muscle inflammation. Some studies have shown that common anti-inflammatory foods have a significant impact on the inflammatory cycle in the body.Some polyphenols can effectively inhibit the pro-inflammatory pathways such as NF - *k* B, and reduce the levels of inflammatory factors such as tumor necrosis factor - α and IL-6 ; Omega-3 endurance trainers the generation of pro-inflammatory mediators and promotes the regression of inflammation, and plays a positive role in muscle recovery; Dietary fiber can indirectly regulate the level and cycle of inflammation by enhancing intestinal barrier function. As a sustainable and controllable intervention, an anti-inflammatory diet can effectively regulate the chronic inflammation of muscle after resistance training, which is a very promising intervention. In the future, further long-term and large sample clinical studies are needed to verify its actual effect.

Keywords: Anti-inflammatory diet; resistance training; chronic inflammation.

1. Introduction

According to statistics, the annual growth rate of the resistance strength training population in China is about 12% from 2020 to 2023. With the increase in the number of resistance training population in China and the highly developed Internet, the Chinese people pay more and more attention to resistance

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training and chronic muscle inflammation. Endurance training is a kind of exercise in which the body adapts and improves by carrying weight. It usually appears in the training plan of muscle hypertrophy pursuers, functional training enthusiasts, or athletes (such as basketball and Sprint). However, 90% to 95% of people will experience delayed muscle soreness after resistance training, which is a normal physiological phenomenon. But sometimes, due to many factors, some people will show the phenomenon of chronic muscle inflammation, which directly inhibits the signal pathway of muscle protein synthesis (such as mammalian rapamycin target protein), and activates protein decomposition pathways such as ubiquitin proteasome system, resulting in negative net muscle protein balance, hindering muscle repair and growth. Secondly, it causes continuous muscle soreness, stiffness and strength decline, which seriously undermines the regularity and feasibility of exercise performance and training plan. And some studies have shown that long-term systemic low-grade inflammation is also a potential risk factor for the occurrence and development of a variety of chronic diseases [1]. The prevention programs for this phenomenon usually include massage, water therapy, and so on. They usually relieve muscle soreness by promoting blood circulation and so on. These programs can alleviate the negative impact of exercise performance caused by chronic muscle inflammation under ideal conditions, but there are certain limitations due to individual time and physical differences.

Based on this, the "anti-inflammatory diet" from the perspective of nutrition has gradually become the focus of resistance training (especially for people in developed cities). Anti inflammatory diet is a dietary model that mainly uses grains, high-quality fats (omega-3 fatty acids, etc.), specific plant materials (anti-inflammatory vegetables, fruits, etc.), and reduces the consumption of high sugar foods, fried foods, trans fats, etc. to regulate the inflammatory cycle in the body and alleviate chronic inflammation. Other studies have pointed out that this diet model can indirectly improve personal obesity by enhancing the richness of intestinal flora through diet [2].

Some studies have shown that an anti-inflammatory diet can prevent the occurrence of chronic muscle inflammation to a certain extent, but most of the literatures have insufficient evidence or limitations due to sample and material problems. Therefore, this article will elaborate and summarize the relationship between an anti-inflammatory diet and the mechanism of chronic muscle inflammation, and ultimately provide some theoretical evidence for the majority of the resistance training population.

2. Impact of Chronic Muscle Inflammation on Trainers

2.1 Ideal Inflammatory Process after Resistance Training

After resistance training, individual muscles will suffer mechanical damage, and then a series of complex metabolic reactions will occur in the body. Among them, ideally, the muscles of the body usually undergo neutrophils/m1 macrophages to promote inflammation and clearance (hereinafter referred to as M1 stage), and then turn into M2 macrophages to dominate anti-inflammatory and repair (hereinafter referred to as M2 stage) after a period of time, and finally, tissue repair and adaptation. Theoretically, this is a self-limiting and highly coordinated process.

2.2 Muscle Chronic Inflammation after Resistance Training

After resistance training, there are many reasons that can lead to chronic inflammation, but the main microscopic reasons are "repeated injury" and "immune cell imbalance".Repetitive injury mainly refers to the process of muscle transition from the M1 stage to the M2 stage is not completed before the next training. This will lead to the failure of muscle repair and anti-inflammation in the next training, and lead to the continuous activation of inflammatory mechanisms and factors (NF - κ B, tumor necrosis factor α, etc.).In this case, the training must be suspended, which greatly affects the training planIf the trainer persists in training, peak et al's article on muscle mechanical injury and muscle inflammation has successfully tested and pointed out again that the negative effect of the superposition of new injury signals on the trainer is mainly that it will lead to the continuous activation of related inflammatory pathways and inflammatory factors (NF - κ B, tumor necrosis factor α), while it is generally believed that the constantly activated tumor necrosis factor α/NF - κ B, pathway will inhibit the mammalian target protein signal of rapamycin and indirectly inhibit the synthesis of muscle proteins [3]. The superposition of injury signals can also activate the ubiquitin proteasome system, which further produces the effect of muscle decomposition.

The research further points out that the continuous inflammatory environment will lead to the dysfunction of immune cells and fall into a vicious circle. In the long-term inflammatory environment, the occurrence of the above mechanism will lead to muscle damage again, which will further increase the level of reactive oxygen species and other oxides, while excessive reactive oxygen species and other oxides exceed the scavenging capacity of the

antioxidant system (glutathione, superoxide dismutase, etc.), leading to oxidative stress [3].These powerful oxides and signaling molecules will continue to activate key pro-inflammatory pathways such as NF - κ B, forcing immune cells to enter the pro-inflammatory state again. When these immune cells are dysfunctional, they will bring more persistent pain and weakness to the trainer's muscles, and will further make the trainer enter a state of reduced immunity and susceptibility to disease.

3. Anti-inflammatory Diet (anti-inflammatory ingredients) and Chronic Muscle Inflammation after Resistance Training

The focus of this paper is to introduce the effect of diet on chronic muscle inflammation after resistance training. For an anti-inflammatory diet, the anti-inflammatory ingredients in food materials mainly play a role, which are polyphenols, omega-3 fatty acids and dietary fiber.

3.1 Polyphenols

In the anti-inflammatory diet, the intake of polyphenol-containing plants is essential. Curcumin, resveratrol and anthocyanins are common polyphenols in daily life. Curcumin mainly comes from a kind of polyphenol compound extracted from the rhizome of Curcuma longa, and it is one of the most popular compounds in the anti-inflammatory field. The anti-inflammatory effect of curcumin is multiple and effective. Fernando and other researchers described in the literature that they showed the markers (such as creatine kinase, etc.) that can significantly reduce muscle injury after exercise after curcumin supplementation for 237 days with active body (moderate and highly active). The effectiveness of curcumin is largely attributed to its strong inhibitory effect on the NF - κ B pathway. The results show that curcumin has a positive effect on inflammation control and muscle damage repair in this population, especially reducing the levels of key pro-inflammatory cytokines such as tumor necrosis factor alpha and IL-6, reducing the persistent inflammatory environment in the body, and providing help for muscle recovery. In addition, curcumin can also reduce oxidative damage by neutralizing or reducing oxidative stress markers (such as malondialdehyde, reactive oxygen species) and enhancing total antioxidant capacity. These biochemical indicators show that curcumin has a regulatory effect on muscle inflammation and soreness [4].

In addition, it is worth noting that resistance training enthusiasts pursuing an anti-inflammatory diet should follow the report of the Joint Expert Committee on food additives of the United Nations and the World Health Organization and the European Food Safety Agency on the daily limit of curcumin. The normal daily intake of curcumin is about 0-3 mg/kg. If excessive intake, diarrhea, headache, rash and other clinical manifestations may occur.

With the deeper understanding of polyphenol compounds, researchers found that resveratrol has an anti-inflammatory effect, and most of them come from blueberries and grapes. In the randomized controlled trial conducted by Edward. Jo et al., 22 subjects (18-32 years old, including men and women) were randomly assigned to the resveratrol supplementation group (n=10) and placebo group (n=12) for 30 days of intervention. During this period, the two groups of subjects performed eccentric contraction exercises such as vertical bounce and leg lift. Finally, the subjects' muscle pain feedback (pain was evaluated by a visual analogue scale), muscle strength (the latest 1RM weight), local pain threshold and tolerance, lower body flexibility, biomarkers of muscle injury and inflammation (blood samples) were detected. The results showed that taking resveratrol did not significantly alleviate muscle soreness, but the content of serum C-reactive protein in the resveratrol group showed a downward trend (– 40.4%, p=0.04) from 24h to 48h, and the image showed that the level of IL-6 decreased significantly after 48h compared with the control group. This study can show that resveratrol (not acute, but long-term) can inhibit the inflammatory environment after resistance trainers' training to a certain extent [5,6]. For general resistance trainers, resveratrol from blueberries and grapes is a more economical and safe intake channel.

Anthocyanins are a kind of water-soluble flavonoid that widely exist in dark berries (such as blueberries, cherries, etc.). Many studies have shown that anthocyanins have a significant impact on muscle strength and validation indicators of athletes. Bauter et al. Asked 9 male subjects with resistance training experience to participate in a single high-intensity resistance training course, including 10 groups of 10 repetitions of single-leg knee extension centrifugal exercise (the intensity is 120% of the maximum autonomous contraction force) and other resistance training. In terms of anthocyanin supplementation, participants were provided with 30ml of concentrated Montmorency sour cherry juice and water twice a day from the fourth day of the training program until four days before the end of the training. At 4, 24, 48 and 72 hours after a single training, the results showed that at 48 and 72 hours after training, the maximum voluntary muscle contraction force of cherry juice group was significantly higher than that of placebo group ($\square$<0.05). For serum creatine kinase index, the creatine kinase activity of cherry juice group at 24, 48 and 72 hours after training was significantly lower than

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that of placebo group (P<0.05); At 48 hours after training, the concentration of IL-6 in cherry juice group was significantly lower than that in placebo group (P<0.05) [7]. These indicators can prove that anthocyanins can help the Resistance Trainer recover muscle strength and improve the inflammatory cycle after training.

3.2 Omega-3

Omega-3 polyunsaturated fatty acids are generally divided into three types: Eicosapentaenoic acid (EPA) (core anti-inflammatory effect). Docosahexaenoic acid (DHA). α - linolenic acid (ALA, usually with low conversion). There are generally three anti-inflammatory pathways of Omega-3. First, omega-3 will combine with the cell membrane of immune cells and compete with arachidonic acid. The more eicosapentaenoic acid and docosahexaenoic acid in the membrane, the less these pro-inflammatory mediators are produced due to competition. Secondly, eicosapentaenoic acid and docosahexaenoic acid are metabolized by enzymes into a class of molecules called specific crude inflammatory regression mediators, which act as signaling molecules to regulate immune cells to end the inflammatory response, remove dead cells and debris, and start tissue repair and regeneration phase (M2). Finally, eicosapentaenoic acid and docosahexaenoic acid can inhibit the activation of NF - κ B, the main pro-inflammatory signaling pathway, by activating some cell surface receptors, thereby reducing the gene expression of a variety of pro-inflammatory cytokines (mainly tumor necrosis factor α).In one study, 16 subjects were randomly assigned to the omega-3 group (taking 4 g fish oil capsules, 1560 mg eicosapentaenoic acid, and 390 mg docosahexaenoic acid every day for four weeks) and the olive oil group (providing the same dose of olive oil as the experimental group for four weeks).After the supplement period, all subjects underwent a one-time eccentric knee extension exercise (eccentric contraction of quadriceps femoris), 5 groups x 15 times, and the intensity was 75% of the maximum voluntary contraction force value. The researchers collected blood samples before resistance training and at 2, 6, 24, 48, 72, and 96 hours after training to measure inflammatory indicators such as tumor necrosis factor alpha, interleukin-6 and C-reactive protein, as well as muscle injury markers such as creatine kinase, maximum voluntary contraction and visual analogue scale (VAS) to assess muscle soreness. The final results showed that, although there was no significant difference between the groups in such indicators as interleukin-6, C-reactive protein, creatine kinase, maximum voluntary contractility value, visual analog scale value, etc., the concentration of tumor necrosis factor alpha in the omega-3 group was significantly reduced [8]. This provides the trainers with ideas for omega-3 to promote the conversion of M1 and M2 after resistance training.

3.3 Dietary Fiber

The intestinal environment is the focus of resistance trainers, and dietary fiber intake will become the key. The anti-inflammatory effect of dietary fiber is not direct, but through its fermentation products by intestinal flora. The main mechanism is the production of short-chain fatty acids by fermentation. Soluble dietary fiber is fermented by beneficial bacteria (prebiotics) in the colon, mainly producing short-chain fatty acids, generally butyric acid, propionic acid and acetic acid. Butyric acid can strengthen the intestinal barrier function, thus promoting the production of tight junction proteins, indirectly reducing the entry of endotoxin (LPS) into the blood circulation, and avoiding the repeated activation of the immune system from the root. Propionic acid and acetic acid can regulate the function of peripheral immune cells and adipose tissue after entering the blood circulation. Secondly, they can inhibit the NF - κ B pathway, reduce the production of pro-inflammatory cytokines (such as tumor necrosis factor - α, interleukin-6), and promote the differentiation of regulatory T cells (Tregs) with anti-inflammatory effect, which provides great help for the regulation of inflammatory environment in trainersOn the other hand, dietary fiber can selectively promote the growth of Bifidobacterium, Lactobacillus and other beneficial bacteria, and create a healthy and balanced intestinal microbiota, which is more conducive to inhibiting the production of pro-inflammatory factors and crowding out the living space of harmful bacteria (especially prebiotic fiber, such as inulin and fructooligosaccharides, which are outstanding in this effect)..It is worth noting that reasonable selection and intake of dietary fiber is one of the most important links that an anti-inflammatory diet can affect the muscle inflammation cycle of resistance trainers.

4. Conclusion

During long-term high-intensity resistance training, the muscle inflammation cycle may be out of balance due to repeated muscle mechanical injury and insufficient recovery, which may lead to a harmful and vicious cycle of chronic inflammation. This state is closely related to the inhibition of muscle protein synthesis, delayed recovery, and even the increased risk of overtraining syndrome, which has become a key potential factor hindering the continuous progress of trainers. As an effective method to regulate the inflammatory cycle, an anti-inflammatory diet is not a single effective mode, but a synergistic overall

dietary mode.This article reviews the regulation of many anti-inflammatory ingredients on the inflammatory cycle, most of which are by inhibiting NF - κ B and other important inflammatory pathways and neutralizing oxidation products. Of course, there are also indirect ingredients, such as dietary fiber, that indirectly regulate the inflammatory cycle and create a good intestinal environment. Based on the existing research, for the healthy people who carry out regular resistance training, it is likely to be a safe and effective strategy to implement the anti-inflammatory diet mode with rich vegetables, fruits (providing polyphenols and anthocyanins), whole grains, beans (providing dietary fiber), omega-3 as the core, and moderate amount of turmeric, nuts (including resveratrol) and other foods, and reduce the pro-inflammatory diet ingredients (high sugar, refined carbon water, trans fat), to relieve muscle soreness, accelerate recovery, optimize the muscle inflammation cycle, prevent the generation of chronic muscle inflammation, and support long-term and planned resistance training.

The main limitation of this paper is that the existing studies pay more attention to single nutrients. Future research should focus on exploring the synergistic effects of these anti-inflammatory ingredients in the whole food mode and the interaction between them and training variables (capacity, intensity, inter-group rest). The second is that the long-term effect of an anti-inflammatory diet on exercise performance, muscle growth and injury prevention needs to be confirmed by more large-scale and long-term randomized controlled trials.

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