Scholar Publishing Group
International Journal of Public Health and Preventive Medicine
https://doi.org/10.38007/IJPHPM.2020.010304
ISSN 2789-8377 Vol. 1, Issue 3: 38-49

Changes of Free Amino Acids in Skeletal Muscle and Serum after Exercise Injury

Xue Li

School of Design, Zhejiang Tech University, Hangzhou, Zhejiang 315100, China

lixue@zjut.edu.cn

Keywords: Sports Injury, Skeletal Muscle, Free Amino Acids, Black Gold Ⅱ Staining

Abstract: The theme of this paper is the change of free amino acid content in skeletal muscle and serum after sports injury. We selected 28 healthy athletes by exclusion and inclusion criteria. They were randomly divided into two groups. The intervention group consisted of 3 h group, 6 h group, 12 h group, 1 D group, 3 D group, 1 W Group and 3 W Group, respectively. After 3 hours, 6 hours, 12 hours, 1 day, 3 days, 1 week and 3 weeks after exercise, tissue sections were established abdominal venous blood was centrifuged to obtain serum. Some skin tissues of skeletal muscle of athletes were extracted and stained with black gold Ⅱ and he, and then the content of free amino acids in skeletal muscle and serum was detected. GraphPad prism 9.0 was used for statistical analysis. According to the experimental results, we found that most of the free amino acids in serum showed a downward trend within 3 hours, and the contents of aspartic acid and glutamine reached the maximum value on the third day. The contents of glycine, threonine, arginine and proline all reached the maximum after one week; in the distribution of free amino acids in skeletal muscle, the contents of proline, glycine and glutamine reached the maximum after days, while the contents of hydroxyproline, aspartic acid and serine reached the maximum within one day; the content of aspartic acid in serum was generally higher than that in skeletal muscle Glycine is an essential amino acid for human body. The content of free amino acids in serum was affected by bone metabolism. The content of amino acids in serum began to rise on the third day, and the content of free amino acids in bone gradually increased after three days. Once some amino acids decrease, it is difficult to recover quickly. It can be seen that timely supplement of amino acids can treat sports injury in time.

1. Introduction

The rapid development of economy and science and technology has greatly changed people's lifestyle and concept. White collar workers in first tier cities, in particular, use computers for a long time. Instead of walking, they drive out. With the rapid decline of physical fitness, people began to carry out a variety of sports activities to improve physical fitness. However, due to the lack of correct fitness guidance, people often have a variety of sports injuries, of which exercise-induced skeletal muscle injury [1] is the most common. Skeletal muscle injury often occurs in high-intensity exercise or long-term moderate intensity exercise, and eccentric contraction of skeletal muscle is more likely to cause sports injury. It shows that high-intensity eccentric exercise is prone to exercise-induced skeletal muscle injury in various sports. After sports injury, there will be an obvious sign: muscle delayed soreness, mainly occurs in a period of time after exercise stops. The main clinical manifestations were persistent muscle soreness or limited limb motor function. The results show that: the occurrence and characteristics of skeletal muscle injury after exercise are related to exercise mode and exercise load. According to a large number of experimental studies, EIMD symptoms are most obvious 24-48 hours after exercise. Therefore, the theory that eccentric exercise [2] is more likely to cause skeletal muscle injury can be used to establish an experimental model of exercise-induced skeletal muscle injury. However, it has been found that low-intensity eccentric exercise can help repair skeletal muscle injury. Centrifugal exercise has dual effects: it can not only cause skeletal muscle injury after exercise, but also promote the repair of skeletal muscle injury. Centrifugal exercise is commonly used in the fitness industry to quickly enhance muscle strength.

Skeletal muscle is a relatively stable tissue. When skeletal muscle is injured, whether it is contusion, strain or tear, it has certain healing ability. However, the regeneration and repair of skeletal muscle injury is a highly coordinated and dynamic process. In recent years, many studies have found that adult skeletal muscle has certain repair potential after injury. Studies have shown that the physiological repair process of skeletal muscle injury can be divided into three stages [3]: the first stage is the formation of hematoma at the site of muscle injury. In the second stage, the satellite cells around the injured muscle were activated, and the fibroblasts restored the connective tissue skeleton. The third stage of tissue formation: skeletal muscle mature regeneration. These three stages are simple destruction of muscle fiber structure, activation of monocytes, including inflammatory cells (macrophages) and muscle derived stem cells (muscle satellite cells), macrophages infiltrating damaged phagocyte fragments, muscle satellite cells activation and proliferation and differentiation into new multinucleated myotubes, and then the multinuclear myotubes further develop into muscle fibers. Although the damaged skeletal muscle can heal naturally after these three stages, the shape and function of the healed muscle are different from that of the original undamaged muscle. After skeletal muscle injury, if not treated in time, it may lead to muscle quality decline, skeletal muscle contraction is limited, and even cause fatal injury to the body. The incidence rate of muscle injury is high. The treatment time, healing time and healing quality will affect the normal physical exercise, sports training and competition in the future. Although the research on the repair of skeletal muscle injury has important clinical significance, the clinical research on the treatment of skeletal muscle injury is relatively less. Therefore, understanding the muscle injury and repair path is of great significance to improve the speed and quality of muscle repair, and to design a reasonable treatment plan.

The repair of skeletal muscle injury starts with the damaged protein, which can stimulate the recovery of muscle glycogen reserve, provide raw materials for skeletal muscle repair, and protect the immune system function [4]. Protein cannot be directly absorbed, it must be transformed into small molecules of amino acids or peptides, in order to be absorbed and used by the human body. Amino acid is the basic unit of protein and participates in a variety of metabolic processes. In fact, the physiological function of protein depends on the metabolism of amino acids. The supplement of protein should be transformed into amino acids, whose nutritional value is determined by the type, proportion and content of amino acids. At present, there are many reports about the effect of protein supplementation on the repair of exercise-induced skeletal muscle injury, but few reports on the effect of amino acid supplementation on the repair of exercise-induced skeletal muscle injury at home and abroad. Previous reports have also focused on the effects of glutamine, branched chain amino acids or taurine on skeletal muscle injury, and the results are still controversial. In addition to glutamine and taurine, the effects of amino acid supplementation on skeletal muscle injury were less reported and more comprehensive. Why these amino acids are supplemented and whether these amino acids have effects on skeletal muscle injury remains to be further studied.

Therefore, this paper studies the changes of free amino acids in the process of skeletal muscle and serum skeletal muscle injury repair, find the change rule of amino acid in the process of skeletal muscle injury repair, and provide experimental basis to reveal the mechanism of skeletal muscle injury repair, reasonable supplement of amino acids and accelerate the repair of skeletal muscle after sports injury. The structure of this paper is as follows: firstly, the influence of sports injury on skeletal muscle is briefly introduced; secondly, the mechanism of skeletal muscle injury, how to determine, the repair process of skeletal muscle, the change of amino acid caused by sports injury and how to repair with amino acid are summarized in detail; then a series of experimental tests are prepared, from reagents and equipment required for the experiment to how to make specimens Finally, it is concluded that when the sports injury is established, the content of various amino acids increases or decreases. When the sports injury recovers, the amino acid content gradually returns to the initial value, but it cannot reach the same level. Finally, the protein produced promotes the overall body function recovery. Therefore, proper supplement of the missing amino acids can promote the recovery of sports injury.

2. Change of Amino Acids and Repair of Skeletal Muscle Injury

2.1. Mechanism of Bone Injury Caused by Sports Injury

At present, the main mechanisms of skeletal muscle injury [5] have been found, including energy consumption theory, calcium homeostasis theory, free radical theory, mechanical injury theory and inflammatory cell infiltration theory. According to the theory of energy metabolism disorder of muscle fiber, the energy stored in skeletal muscle fiber is rapidly consumed, while the energy generation speed in cells is relatively slow, which cannot provide the energy needed by muscle in time. The energy supply in muscle fiber cannot meet the energy required for muscle contraction, and a large amount of waste generated during exercise accumulates in muscle cells. It may be an important cause of skeletal muscle injury. According to the theory of calcium homeostasis [6]: calcium ion is an essential ion in many life activities. The normal contraction of skeletal muscle must involve calcium ion; cell proliferation and differentiation; in skeletal muscle cells, calcium ion is also an important promoter of nerve impulse into muscle contraction. Some studies have also shown that the long-term existence of high concentration of calcium ions in the cytoplasm will lead to the apoptosis of normal muscle fibers, and eventually lead to muscle fatigue and injury. According to the theory of free radical damage, free radical is a kind of strong oxidizing compound produced by redox reaction in vivo, which can destroy many important macromolecules involved in life activities and interfere with normal life activities. We found that after muscle fatigue or injury, the number of free radicals in the body will increase rapidly, and high-intensity static exercise will also lead to the increase of free radicals. It can cause changes of GSH-Px, SOD and MDA, and further damage skeletal muscle.

The theory of mechanical injury [7]: during intense exercise, skeletal muscle is constantly contracting violently, and thousands of muscle fibers in muscle are also constantly contracting with high intensity. Muscle fibers are constantly stretched, resulting in muscle fiber membrane damage and surrounding connective tissue damage. Experimental studies show that: skeletal muscle after a long time of high-intensity centrifugal contraction, there will be a large number of muscle protease in serum; and the appearance of muscle protease in serum also has the characteristics of delay, similar to the appearance of skeletal muscle delayed muscle soreness. High intensity centrifugal contraction can destroy the muscle membrane of muscle fiber and produce a large amount of protease in serum, which indirectly proves the mechanical injury theory of skeletal muscle injury. In addition, there are a lot of protease in muscle after strenuous exercise, which is related to the ultrastructural changes of muscle fiber after strenuous exercise. According to the theory of inflammatory cell infiltration, muscle fibers are subjected to high-intensity traction when muscles contract intensively. It can destroy the ultrastructure of muscle fiber and release a lot of inflammatory factors. This may be the cause of skeletal muscle injury. In recent years, studies have shown that when the ultrastructure of muscle fiber is damaged, the muscle will release inflammatory chemokines and induce a large number of inflammatory cells to gather in the muscle injury site.

2.2. Evaluation Index of Skeletal Muscle Injury

According to the research, the evaluation of skeletal muscle injury index mainly includes muscle histomorphology observation, serum related protease detection and biological immunology detection. The morphological observation is paraffin section or frozen section of experimental tissue, and then he is staining. The difference between the two groups was observed under light microscope. This detection method can directly reflect the situation of skeletal muscle injury. At present, the commonly used detection methods of serum related protease are based on the theories of skeletal muscle injury, energy failure and metabolite accumulation and mechanical injury. The detection of serum muscle enzymes after exercise can indirectly explain the situation of skeletal muscle injury. The commonly used biochemical indicators include creatine kinase (CK), lactate dehydrogenase (LDH), myoglobin (MB), myosin heavy chain (MHC), etc., but each index cannot be used as a very reliable index to detect skeletal muscle injury, which requires the combination of multiple indicators to be reliable.

There are two kinds of CK subunits: one is M type, which is mainly located in muscle cytoplasm; the other is type B, which mainly exists in the cytoplasm of brain tissue. Therefore, the CK composed of these two subunits is an enzyme complex with the size of about 82 KDA. Myocardial CK-MB is composed of M-type and B-type subunits. The CK-MM of skeletal muscle consists of M-type and B-type. CK BB in brain tissue is composed of a subunit of type B. These three enzymes are called CK isozymes. CK mm mainly exists in skeletal muscle, accounting for 98% of the total amount of CK. In normal body condition, muscle fiber structure is complete all kinds of functions are normal. Muscle marker enzymes in muscle tissue cannot appear in blood through cell membrane, which leads to the increase of muscle marker enzyme concentration in blood. However, when the human body does not exercise for a long time, suddenly or does not exercise habitually, or takes part in acute high-intensity exercise training, the concentration of CK in serum is significantly higher than that in resting time. The main reason for this phenomenon is that the muscle fibers are stimulated by external strong mechanical stimulation or the accumulation of metabolites in muscle fibers, which causes the changes of intracellular environment.

2.3. Skeletal Muscle Repair Process

The whole process of skeletal muscle repair is continuous, including phagocytosis of damaged cells, infiltration of inflammatory cells, activation and differentiation of satellite cells to complete the repair of injury. The phagocytosis of injured cells was mainly completed by macrophages and transferred to the injured site under the action of chemokines. The basis of skeletal muscle repair is the integrity of basement membrane, recovery of blood circulation and homeostasis of internal environment [8]. The activation of muscle satellite cells [9] requires the cooperation of many related biological factors, among which inflammatory factors are an indispensable part. Muscle satellite cells are the only kind of stem cells in skeletal muscle, which play an important role in the repair of injury thickness. Some studies have shown that: in the repair of skeletal muscle injury, the satellite cells in the normal position of skeletal muscle can be transferred to the injured site to participate in the repair process. At the same time, the literature suggests that inflammatory cells play a dual role in muscle satellite cells, which can activate or inhibit their proliferation and differentiation. Muscle satellite cell is a kind of stem cell, which can repair skeletal muscle through activation and proliferation. Under normal conditions, skeletal muscle satellite cells are flat and protuberant cells. After being stimulated by external stimuli such as injury, satellite cells activate from quiescent state and start DNA. After the muscle satellite cells proliferated to a certain number, some cells began to differentiate into myoblasts, myoblasts differentiated into myotube cells. Multiple adjacent myotube cells fused to form new muscle fibers or fused with damaged muscle fibers to repair damaged muscle fibers. The results showed that inflammatory cell infiltration occurred in skeletal muscle within 24 hours after injury, proliferation and differentiation of muscle satellite cells occurred at 48 hours after injury, and myotube formation occurred 3 days after injury.

2.4. Effect of Sports Injury on Amino Acids

Scholars have done a lot of research on exercise and the changes of amino acids. We found that after long-term exercise, most amino acids increased, alanine and branched chain amino acids increased in the same direction, and 80% of amino acids decreased. The content of serum free amino acids was measured after extreme load exercise. The results are not consistent with the report. The author explains that this is due to different exercise intensities. The concentrations of these 11 amino acids and histidine decreased immediately after exercise. This may be due to the increase of cell damage, hypermetabolism of muscle fibers and the regeneration of red blood cells, and the stress of hormone and nerve regulation during exercise, which makes the protein decomposition rate significantly higher than that of synthesis, and the degradation of net protein, resulting in the increase of amino acid content. With the extension of time, after endurance exercise, the glycogen reserves in the body are greatly consumed, the concentration of glucocorticoid increases, and the demand of amino acids in various tissues and organs increases. Amino acids participate in metabolism through gluconeogenesis. The results showed that acute exercise had a significant effect on serum catecholamine [10], while moderate intensity two-week treadmill training had little effect on catecholamine concentration, suggesting that the change of catecholamine may lead to the increase of amino acid mobilization during exercise.

Amino acid is the basic component of skeletal muscle protein, and also the energy substance of skeletal muscle. The branched chain ketoacids are formed in muscle by trans amination, which completely oxidizes and releases energy. Exercise training can improve the ability of skeletal muscle oxidation and utilization. The mechanism may be that exercise training can improve the secretion of metabolism related hormones, increase the activity of oxidative enzymes and energy utilization efficiency.

2.5. Amino Acids and Sports Injury Repair

The protein degradation of both young and old people increased during 80% VO2max and 45 minutes centrifugal exercise, which may be caused by myofibrillar protein hydrolysis. The metabolism of leucine was studied by isotope tracer technique. It was found that the content of leucine increased by 9% immediately after exercise, 19% immediately after exercise, and increased by 15% on the 10th day after exercise. The results showed that the synthesis and metabolism of protein were inhibited, while the catabolism was enhanced, resulting in the net degradation of protein.

Is amino acid supplementation effective in repairing muscle injury? Some scholars first discovered the effect of amino acid mixture on economic recovery, eccentric exercise caused by muscle structure damage, and then discussed the influence of amino acid dosage on muscle injury in the process of middle and long-distance running training, and finally selected the corresponding dose for long-term observation. The results showed that oral amino acid mixture can eliminate muscle fatigue, reduce the damage of muscle integrity caused by strenuous exercise, enhance the ability of blood oxygen transportation and improve the exercise ability.

3. Changes of Free Amino Acids in Skeletal Muscle and Serum after Sports Injury

3.1. Subjects

We selected 28 healthy athletes by inclusion and exclusion criteria. They were randomly divided into two groups. The intervention group consisted of 3 h group, 6 h group, 12 h group, 1 D group, 3 D group, 1 W Group and 3 W Group, respectively. After 3 hours, 6 hours, 12 hours, 1 day, 3 days, 1 week and 3 weeks after exercise, tissue sections were established abdominal venous blood was centrifuged to obtain serum. The changes of free amino acids in skeletal muscle and serum were recorded by black gold Ⅱ staining.

3.2. Establishment of Athletes' Sports Injury

All athletes run slowly downhill, but the duration should be strengthened. The speed is 300 m / min, the height of the slope is 30 °for different periods of training, each training time is 2 hours.

3.3. Reagents Required

Table 1. Reagents required for the experiment

Reagent name	Company
HCl	Guangzhou Guoyao Group Chemical Reagent Co., Ltd
Chloral hydrate	Guangzhou Guoyao Group Chemical Reagent Co., Ltd
Hematoxylin	Guangzhou Guoyao Group Chemical Reagent Co., Ltd
Chloral hydrate	Guangzhou Guoyao Group Chemical Reagent Co., Ltd
Anhydrous ethanol	Sigma
Xylene	Sigma
Twain-20	Sigma

Shown as Table 1, the names and sources of reagents needed in this experiment are described.

3.4. Equipment Required

Table 2. Instruments required for the experiment

Equipment name	Source of equipment
Leica rm2135 paraffin section machine	LEICA
Leica hi1210	LEICA
Autoclave	LEICA
5 ℃ high speed centrifuge	LEICA
Table type thermostatic oscillator	Guangzhou Pudong Rongfeng Scientific Instrument Co., Ltd
Olympus DX70 optical microscope	Guangzhou Pudong Rongfeng Scientific Instrument Co., Ltd
Fa2004 electronic balance	Guangzhou Pudong Rongfeng Scientific Instrument Co., Ltd

Shown as Table 2, the instrument and the name of the instrument source company are described.

3.5. Sample Preparation

The skin tissue was soaked in 10% chloral hydrate (400mg / 1000g body weight) for 10 minutes. The extracted skin tissue was fixed on the operating table to expose the whole structure. The abdominal blood samples were extracted without any additives 5ml. The upper serum was collected by pipette and transferred to the centrifuge tube for cryopreservation. And extract part of the muscle skin tissue, alcohol wash; take out the muscle surface fat. The water on the surface of the tissue was dried with filter paper, and the muscle was quickly immersed in isopentane cooled by liquid nitrogen with long tweezers and stirred slowly for about 10 s. Completely frozen skin tissue quickly transforms from isopentane to dry ice. After about 15 minutes, isopentane volatilized on the surface of skin tissue, wrapped with tin foil, marked with grouping, name and time of skin tissue, and stored in ultra-low temperature refrigerator for use.

(1) One hour in advance, set the temperature of frozen microtome: freezing head temperature - 27 ℃, box temperature - 24 ℃.

(2) When the microtome temperature drops to the preset temperature, the skin tissue is removed from the ultralow temperature refrigerator and placed in a cryostat for half an hour.

(3) After tissue balance, a small piece of rectus femoris abdomen was cut. After OCT was coated on the sample holder, the repaired tissue was immediately placed on the sample holder, and OCT was loaded into cryoprobe after solidification.

(4) Adjust the thickness to 7um. After slicing, paste the mark with the treated slide, dry it with air dryer and put it into the slice box for use.

3.6. Black Gold Ⅱ Staining

Black gold II staining [11] is to place tissue slices in 4% paraformaldehyde fixed for 15 minutes, oven drying, infiltration into DDH_ 2O for 2 minutes, then placed on a foam board, placed in a 60 degree water bath, cut into black gold II dye, pre heated, placed in 20 minutes, then removed, cut DDH_ 2 O and rinse 2. Drop the preheated sodium thiosulfate solution on the tablet, take it out in 60 ℃ water bath for 10 min, and wash it with ddH2O twice. At room temperature, crystal violet was dropped on the slices, stained at room temperature for 3 min, and then DDH was used_ Soak in water. Then the ethanol was dehydrated by gradient, xylene was transparent, sealed with neutral glue, and the pictures were observed and collected under light microscope.

3.7. HE Stain of Skin Tissue

The fixed gastrocnemius muscle tissue was removed from paraformaldehyde and washed with running water for 5 min. The flow of water is slow the volume and shape of the tissue are trimmed. Put the cut tissue into a net bag made of cotton thread and gauze. They were soaked in 50% alcohol for 12 hours, 75% alcohol for 1 hour, 85% alcohol for 1 hour, 95% alcohol for 45 minutes, 95% alcohol for 45 minutes, 100% alcohol for 15 minutes for gradient alcohol dehydration; then they were transferred to 100% alcohol mixed with dimethyl benzene for 30 minutes, xylene for 30 minutes, and xylene for 30 minutes for tissue transparent treatment for 10 minutes, Then they were immersed in xylene and paraffin mixture for 1 hour (60 ℃), paraffin Ⅰ for 1 hour (60 ℃) and paraffin Ⅱ (60 ℃) for 12 hours. Open the tissue gauze, soak it in the wax box on the operating table of the embedding machine, put the tissue block into the embedding frame, fill the liquid wax, wait for cooling, label, take out the wax block for use.

The wax block was cut into 5 ×m thick continuous tissue slices by paraffin section machine, and then spread and baked. The glass slides of the dryer were collected and placed in an oven at 37 ℃. Tissue sections were removed from the oven, and treated with xylene for 3 minutes (2 times), 100% alcohol for 3 minutes (2 times), 95% alcohol for 3 minutes (2 times), water washing, hematoxylin staining for 6 minutes, running water for 3 minutes, 1% hydrochloric acid alcohol for 2 seconds, running water for 3 minutes, eosin reagent for 3 minutes, 3 minutes for 85% alcohol, 95% alcohol for 3 minutes (2 times), and 100% alcohol for 3 minutes (2 times). Finally, seal the fume hood with a neutral resin adhesive, and lay the slices flat until dry. The slices were observed under bx53f optical microscope, and the images were collected by computer software.

3.8. Sample Testing

HPLC analysis [12]: mobile phase A: weigh 8.203g anhydrous sodium acetate solution, dissolve in 1000ml double distilled water, take out 7ml solution, add 7ml acetonitrile, and mix with glass rod. The mobile phase a was 0.1 mol / L sodium acetate buffer solution: acetonitrile (93:7, V: V) solution; mobile phase B was composed of methanol: acetonitrile: water (1:3 1, V: V: V) solution.

3.9. Data Statistics

GraphPad prism 9.0 was used for statistical data to test the changes of amino acids in serum and skeletal muscle, which made the experiment more accurate.

4. Results and Discussion

4.1. Changes of Free Amino Acid Content in Serum of Athletes in Each Group

Shown as Figure 1, the variation trend of the nine amino acids isolated one after another. The content of aspartic acid in each time period was significantly lower than that in other groups, among which glycine was the most abundant. Serine was the highest among all kinds of amino acids in each group, and reached the peak at 6 hours. The content of aspartic acid and glutamine reached the peak on the third day; the content of hydroxyproline was the highest without any intervention, and the content of hydroxyproline was less and less after the intervention; the content of glycine, threonine, arginine and proline reached the peak after 1 week; the content of histidine was also in the situation of no intervention As time goes on, there is no rule to find. In different amino acids, except hydroxyproline content decreased in different time periods after sports injury, others had an upward trend in a certain period of time.

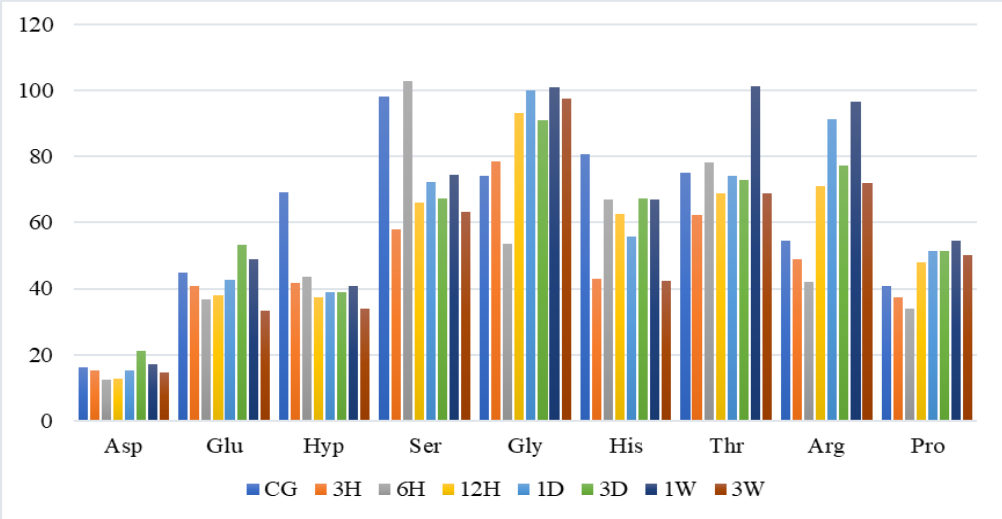

Figure 1. Change trend of serum amino acids in each group

4.2. Changes of Free Amino Acid Content in Skeletal Muscle

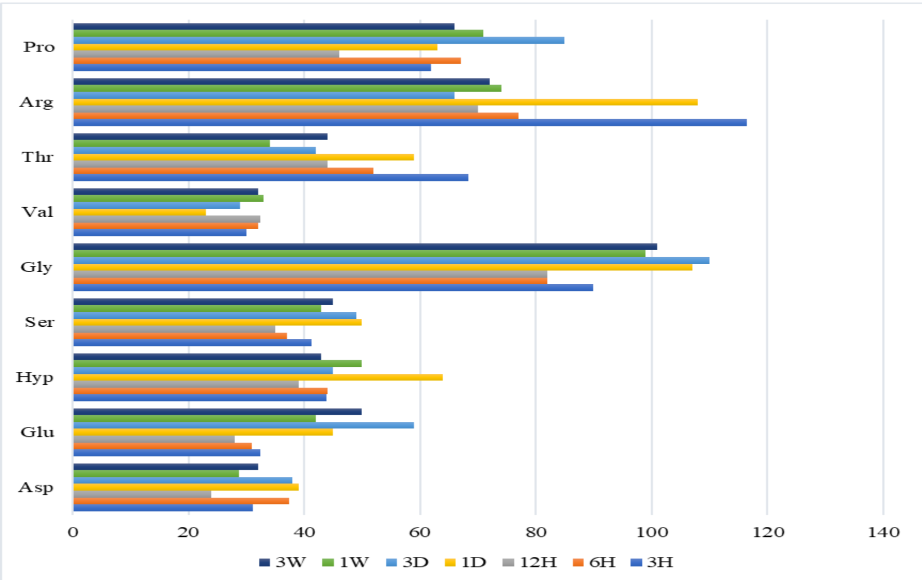

Figure 2. Changes of free amino acids in skeletal muscle

Shown as Figure 2, the contents of arginine and threonine were the highest without intervention, and decreased at different time points after exercise training. Arginine decreased to the lowest after 3 days, while threonine decreased after 1 week. The contents of proline, glycine and glutamine reached the peak after 3 days, but they became lower and lower after 1 week and 3 weeks. The contents of hydroxyproline, aspartic acid and serine reached the peak within one day, and then began to decrease. The content of valine was the lowest at 1 day, and similar at other times.

4.3 Comparison of Amino Acids in Serum and Skeletal Muscle

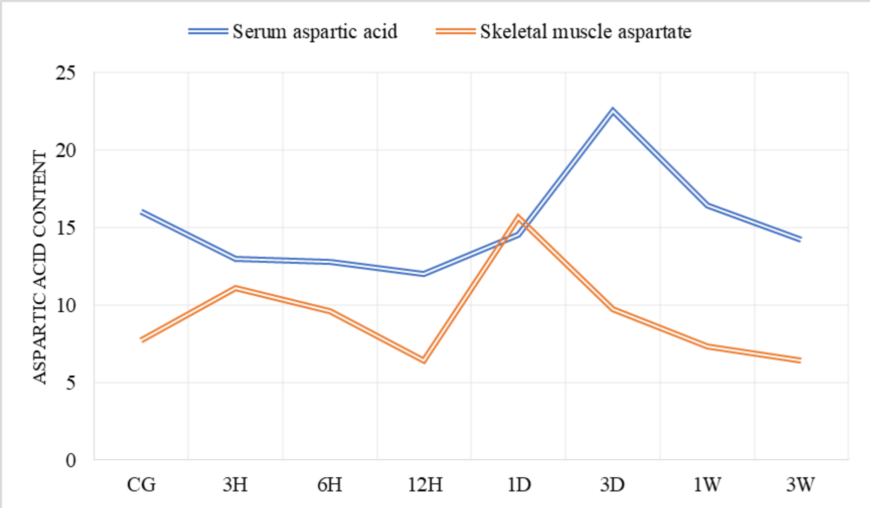

Figure 3. Changes of amino acids in serum and skeletal muscle

Shown as Figure 3, the content of aspartic acid in serum is generally higher than that in skeletal muscle. The content of aspartic acid in serum in the first 12 hours was lower than that in the control group, which indicated that the aspartic acid after exercise training was consumed in a short period of time, and then increased linearly from 12 hours later until reaching the peak value on the third day. However, the content of skeletal muscle in 3 hours was higher than that in control group. If it was more than 3 hours, it began to decrease, until 12 hours later; the content began to rise and reached the peak. The content of aspartic acid in serum was higher than that in this period.

4.4. Amino Acid Requirement Analysis

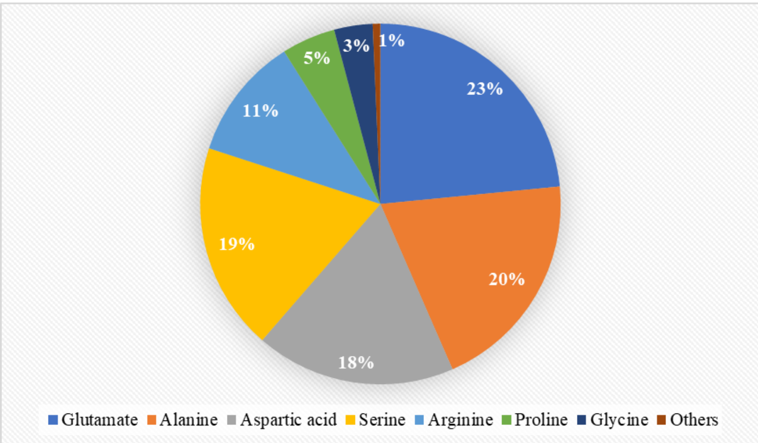

Figure 4. Distribution of important amino acid requirements

Shown as Figure 4, glycine is the most needed amino acid in human body, accounting for 23%. Secondly, histidine, threonine and proline accounted for 20%, 19% and 18% of human body, while other amino acids accounted for less.

5. Conclusion

At present, the commonly accepted definition of exercise-induced skeletal muscle injury is the change of muscle morphology and function, which cannot maintain normal physiological state. The repair process of skeletal muscle injury can be divided into the following stages: the first stage is that the damaged and necrotic muscle fibers are phagocytized and digested by immune macrophages; the second stage is the division and proliferation of muscle fiber satellite cells; the third stage is the further differentiation of multinuclear myotubes into mature muscle fibers. In recent years, a large number of studies on the repair of muscle injury show that the self-healing of skeletal muscle cannot achieve the degree of restoring the original shape and function of injured muscle. Researchers also treat it in various ways, but there are various sequelae. It is reported that muscle fibrosis, atrophy, decreased muscle contractility and even treatment failure will occur after muscle injury is treated by drug therapy, cytokine therapy and stem cell transplantation. As a new hope, the role of missing amino acids in the repair of muscle injury brings a new dawn for the treatment of muscle injury.

Sports injury is that some muscles appear slight swelling; muscle fibers around the blood vessels appear obvious bulky, part of the cytoplasm is engulfed, a large number of white blood cells diffuse, a small number of damaged cells are eliminated, the vast majority of survival. As a result, people will find muscle pain unbearable. In this paper, the skin tissue of athletes with muscle injury caused by exercise intervention was extracted for this experiment, and a small amount of blood was properly extracted for standby. The results showed that the free amino acids in serum were formed by various transformation mechanisms. Due to the large amount of reserve materials consumed during exercise, the free amino acids entered the muscle tissue and began to work. Among them, the content of aspartic acid and glutamine increased gradually in the change of amino acid content after 3 hours. Glycine, threonine, arginine and proline decreased significantly, which reached the maximum after one week. The contents of free amino acids proline, glycine and glutamine in skeletal muscle also reached the maximum on the third day. The contents of hydroxyproline, aspartic acid and serine are better than others. They can reach the maximum value on the first day of training intervention. It can be seen that 1-2 days after exercise produces the most-free radicals, which causes a large amount of lysosomal substances and activates inflammation. At the third week, we found that the free amino acids in serum were lower than those in control group, and the number of amino acids in bone returned to the original level. Therefore, we can conclude that when the sports injury gradually recovers, the amino acid content gradually returns to the initial value, but cannot reach the same level. The final protein can promote the overall body function recovery. Therefore, proper supplement of the missing amino acids has good curative effect on sports injury.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Marni D. Boppart, Dean J. Burkin, & Stephen J. Kaufman. (2015). α7β1-integrin regulates mechanotransduction and prevents skeletal muscle injury. American Journal of Physiology, 290(6), 1660-1665. https://doi.org/10.1152/ajpcell.00317.2005

[2] Huang, W., Moon, S., Gao, Y., Li, Z., & Wang, J. (2017). Eccentric needle motion effect on near-nozzle dynamics of diesel spray. Fuel, 206(oct.15), 409-419. https://doi.org/10.1016/j.fuel.2017.06.012

[3] Cordero, A., Hernández-Gascón, B., Pascual, G., Bellón, J. M., Calvo, B., & Pe?A, E. (2016). Biaxial mechanical evaluation of absorbable and nonabsorbable synthetic surgical meshes used for hernia repair: physiological loads modify anisotropy response. Annals of Biomedical Engineering, 44(7), 2181-2188. https://doi.org/10.1007/s10439-015-1503-4

[4] Guo, Q., Tang, C., & Huang, S. (2018). The mechanism of ultra-early massage on membrane repair in acute skeletal muscle injury. Chinese Journal of Rehabilitation Medicine, 33(2), 151-157.

[5] Pottecher, J., Kindo, M., Chamaraux-Tran, Thiên-Nga, Charles, A. L., Lejay, A., & Kemmel, Véronique, et al. (2016). Skeletal muscle ischemia-reperfusion injury and cyclosporine a in the aging rat. Fundamental & Clinical Pharmacology, 30(3), 216-225. https://doi.org/10.1111/fcp.12180

[6] Emily S Wires, Kathleen A Trychta, Susanne Bäck, Agnieszka Sulima, Kenner C Rice, & Brandon K Harvey. (2017). High fat diet disrupts endoplasmic reticulum calcium homeostasis in the rat liver. Journal of Hepatology, 67(5), 1009. https://doi.org/10.1016/j.jhep.2017.05.023

[7] Mukhin, A. G., Ivanova, S. A., Allen, J. W., & Faden, A. I. (2015). Mechanical injury to neuronal/glial cultures in microplates: role of nmda receptors and ph in secondary neuronal cell death. Journal of Neuroence Research, 51(6), 748-758.

[8] Kim, K. (2015). Interaction between hsp 70 and inos in skeletal muscle injury and repair. Journal of Exercise Rehabilitation, 11(5), 240-243. https://doi.org/10.12965/jer.150235

[9] Dayanidhi, S., & Lieber, R. L. (2015). Skeletal muscle satellite cells: mediators of muscle growth during development and implications for developmental disorders. Muscle & Nerve, 50(5), 723-732. https://doi.org/10.1002/mus.24441

[10] Peyron, C., Pierre乭ervé Luppi, Fort, P., Rampon, C., & Jouvet, M. (2015). Lower brainstem catecholamine afferents to the rat dorsal raphe nucleus. Journal of Comparative Neurology, 364(3), 402-413.

[11] Robins, J. (2019). Black gold. Ports & Harbors, 64(4), 25-25. https://doi.org/10.2134/csa2019.64.1110

[12] Cheng, S., Qiu, F., Wang, S., & He, J. (2015). Hplc analysis and pharmacokinetics of icariin in rats. Journal of Separation ence, 30(9), 1307-1312. https://doi.org/10.1002/jssc.200600313