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The Effect of BCAA Supplementation in Aiding Muscle Soreness to Prevent Lateral Ligament Ankle Injuries in Basketball

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Abstract: Ankle injuries are very common in basketball, with 45% of basketball players experiencing at least one sprain at any point in their career and 53.7% of missed playtime is caused by ankle injuries. These injuries can be caused by overworking muscles and causing them to reach maximum tension and soreness. When this happens, the surrounding ligaments and tendons are more susceptible to injury since the muscles that they hold together are weaker and don't function at full strength. The purpose of the study is to understand if athletes will benefit from taking supplements of Branched Chain Amino Acid (BCAA), to prevent ankle injuries from high a vertical mobility sport like basketball, which includes vertical jumps, layups and re-bounds. Using a combination data collected from control group vs placebo group we proved that BCAA reduces muscle soreness. This is proved by lower soreness scores, and lower values of Creatine kinase (CK) in the blood by the control group that took BCAA. We then proved there is a direct linkage between soreness and muscle fatigue by referring to a study conducted on lateral muscle of Rabbits, which show muscle fatigue, cause soreness and resulting in lower energy production and instability in function, leading to Injury. Based on the study, we comprehensively conclude that BCAA can help reduce risk of ankle injury by reducing muscle soreness and fatigue in basketball players, thereby promoting stable lateral and ankle dorsiflexor muscles.

Keywords: Sports Medicine, Basketball Injury, Ankle Sprain, Athletic Injuries

1. Introduction

Ankle injuries are very common in basketball, with 45% of players experiencing at least a sprain at one point in their basketball career. Ankle injuries account for around 22% of all basketball related injuries, and in the NBA, game-related ankle injuries make up 14.7% of all the injuries in a year on average. Additionally, these injuries are also one of the most severe and difficult to recover from. 53.7% of playing time missed is caused by ankle injuries in basketball. A sprain, one of the most common types of basketball injuries, is when a tear in a ligament occurs. In specific, lateral ligament ankle sprains comprise 80.2% of all ankle injuries, and these usually occur due to contact with another player. Sprains can be categorized as Grade 1, being just a mild small tear; Grade 2, being moderate where the ligament is torn but not completely; and Grade 3, where the ligament is torn completely. Symptoms of an ankle injury include pain when putting weight on the ankle, swelling, bruising, and difficulty or incapability of walking.

Soreness can lead to ankle sprains due to micro tears in muscle fibers which weakens those muscles. The tears trigger inflammatory responses, and as this happens, the body then repairs these tears and the muscles become stronger. Muscle soreness is an expected result of exercise and is needed in order to build stronger muscle through the repair process. One form of muscle soreness that contributes to injury is called delayed onset muscle soreness (DOMS) [4, 2]. DOMS occurs around 24 hours after exercise and causes reduced range of motion and weaker muscles which are more susceptible to injury. A common supplement used to decrease muscle soreness is Branched Chain Amino Acids (BCAA), which alleviate muscle soreness and build muscle. BCAA differs from other supplements as it focuses on muscle

recovery rather than muscle growth. [14]

As of right now, present research has not identified a direct connection between BCAA supplementation and reducing injury. This is important to research because it can prevent ankle injuries that many athletes face. The purpose of this study is to synthesize current literature and identify the effects of BCAA supplementation on ankle injury prevention. It is hypothesized that BCAA's can reduce muscle weakness which will therefore reduce injury rates significantly. [6] This research was conducted via Literature review from databases such as PubMed, Google Scholar, and Science Direct.

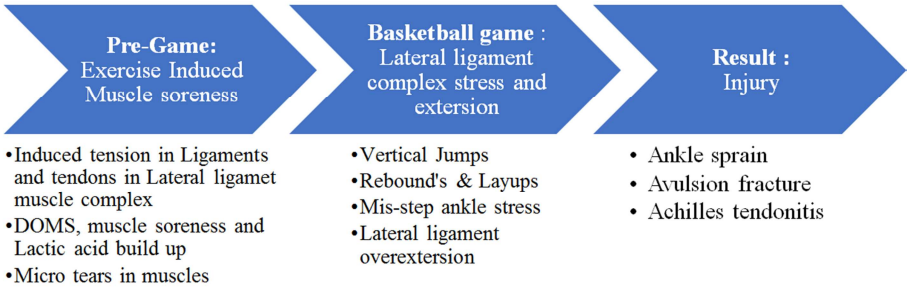

Figure 1. *Events leading up to an Lateral Ligament Injury.*

2. Background

The soreness that you feel is a result of microtears on muscle fibers. The tears trigger inflammatory responses. As this happens, the body then repairs these tears and the muscles become stronger. A common form of muscle soreness is delayed muscle soreness, or DOMS. This occurs days after exercise and is a result of the body feeling that its muscles are weaker than usual due to the micro tears. [7]

When muscles are at a weakened state it can cause a reduction in range of motion in joints; reduction in shock attenuation, which is measuring the force impact from your foot to the ground while running; and decreased peak torque of these muscles, which measures the maximum amount of torque or strength output by a muscle in motion.

2.1. Research Question

What is the effect of BCAA supplementation to aid muscle soreness and fatigue in preventing injury to lateral ligaments and tendons in the ankle, specifically in basketball?

2.2. Weaker Muscles Leading to Muscle Injury

Human fast twitch fiber types, or type 2 fibers are able to generate high power in a shorter amount of time, but are easily fatigued, whereas slow-twitch fibers, type 1, produce less power and have a higher threshold for fatigue. Basketball is considered both high intensity and endurance. The high intensity aspects of the game require mainly anaerobic metabolism and type 2, fast twitch fibers, which have short term contractions, and use anaerobic respiration, which is where cells break down sugars to generate energy without oxygen. [8]. On the other hand, endurance is very important, and this facet of the game uses aerobic respiration which focuses on high efficiency in its oxygen to energy production. Muscle soreness and overall fatigue has been linked with injuries due to the muscles weakened state and inability to perform at its max capability. Glycogen, the sugars that cells break down to create energy, is directly correlated to endurance, and when muscle glycogen content is low, players have worse endurance. Additionally, glycogen oxidation is a major source for ATP regeneration, a process which produces energy, in high intensity exercise. When these processes are limited, it leads to weaker muscles, as they are not able to produce enough energy to function at a high level. A weaker muscle is more susceptible to injury because it is not able to endure stress on a muscle caused by exercise or usage. [9, 5]

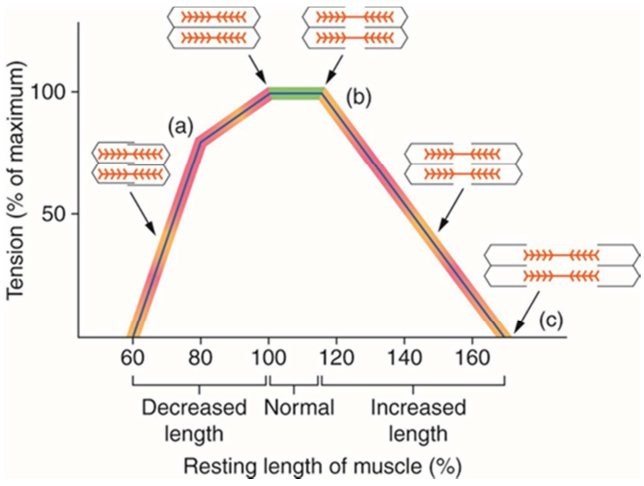

Figure 2. *Stress Strain Tension on Lateral ligament muscle group.*

The graph shows strain in the x-axis and stress in the y-axis. As strain increases stress follows a unique pattern. In the beginning, the muscle is in the elastic region, which is when the muscle can withstand the stress being put on it and return to its normal state [7]. At a certain point, the muscle reaches its yield tensile strength. The yield tensile strength is the amount of strain and stress a material can withstand without permanent deformation. After this, it reaches the plastic region, which is when the muscle cannot withstand the strain and does not return to its original state. This is when injuries occur, because the muscle is not able to overcome the amount of stress being put on it. Finally, the

muscle reaches its ultimate tensile strength, which is the complete maximum strain it can withstand before breaking. Muscles that are more fatigued absorb less energy which increases the chance for spontaneous injuries. [12, 1]

A common supplement taken is Branched-Chain Amino Acids, or BCAA. BCAAs stimulate the building of a protein in a muscle and reduce muscle breakdown. [15]. They allow for more intense workouts with faster recovery times [13]. They can be used post or pre workout; supplementing BCAA after a workout will aid muscle recovery while using it before will aid muscle strength and provide energy boosts. BCAAs are used for athletes who want an extra muscle edge on top of a high protein intake, and not for those who require more protein in their diet. Standard dosage is 200mg per kg of body weight. BCAAs facilitate glucose uptake and enhance glycogen synthesis. [3]. The glucose provides energy to your muscles during exercise and the leucine in BCAA induces the process of muscle protein synthesis. Amino- acid mixtures with BCAA's preserve muscle fiber size and improve physical endurance. They also promote mitochondrial biogenesis, which is the process that increases metabolic enzymes for glycolysis, and functions in cardiac and skeletal muscles. "Free form" BCAAs are absorbed quicker into the bloodstream and delivered faster to your muscles. BCAAs before, during, or after a workout help reduce muscle breakdown and soreness and increase protein synthesis to rebuild muscle.

3. Results

DOMS and muscle soreness in general causes muscles to be weaker and more fatigued [11]. However, BCAA supplementation combats this by increasing glycolysis in order to repair microtears in muscles faster.

A research paper completed in Oct 10th, 2018, titled "Effect of Branched-Chain Amino Acid Supplementation on Recovery Following Acute Eccentric Exercise" helps us understand the connection between BCAA and muscle soreness. This study involved 20 participants, half using BCAA and half using a Placebo. They all had similar physical traits and age, as well as protein intake and calorie intake to minimize outside factors effecting the data. To measure soreness in muscles, the study used a blood draw to measure Creatine kinase (CK) levels in the body. A CK test may be used to detect inflammation of muscles or muscle damage due to exercises or other scenarios like muscle degeneration or myopathies. [1]. Perceived muscle soreness is due to inflammation and slight tearing in muscle fibers which can be measured through CK tests. Each participant had a baseline test, pre-BCAA, then followed a regiment which involved exercise testing and blood draws every day at regular intervals. Exercise testing consisted of three explosive lower body exercises, vertical jumps, isometric quad contractions and squat jumps.

The study found that perceived soreness by patients who used BCAA was much lower than that of the patients who received a placebo (PLCB). In specific, there was a big discrepancy between the BCAA and PLCB perceived soreness at 24, 48, and 72 hours. This means that the patients had less pain from muscle soreness after taking BCAA supplementation, which can be attributed to quicker repairing of muscle fiber tears due to BCAA. [1]

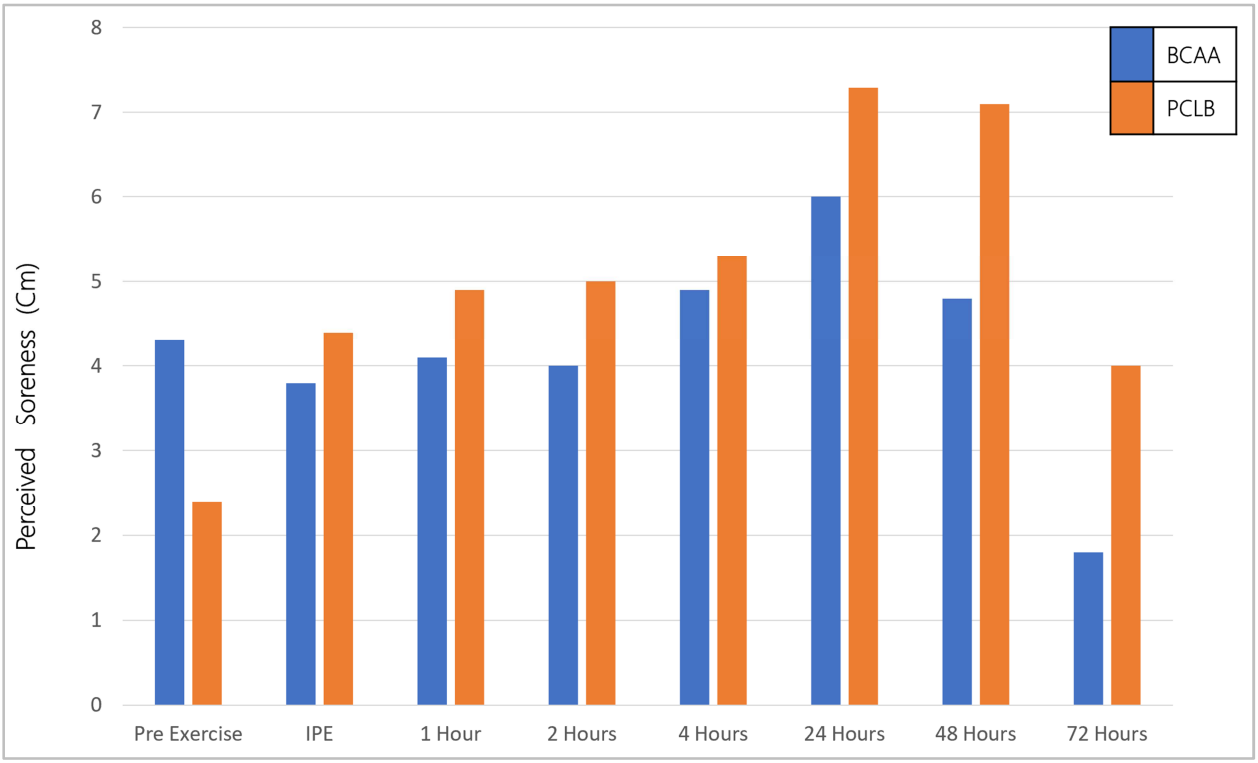

Figure 3. *Effect of BCAA Supplementation on Recovery Study Perceived Soreness Results.*

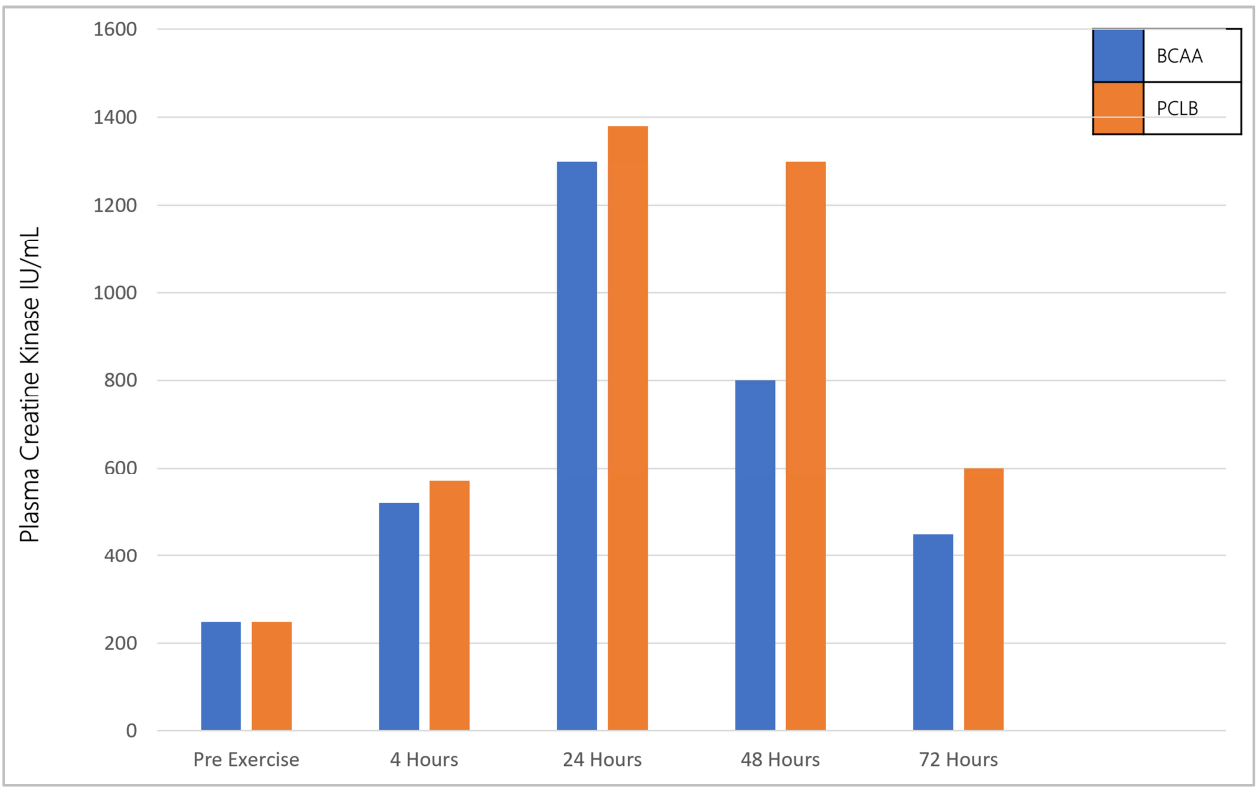

Figure 4. *Effect of BCAA Supplementation on Recovery Study CK Levels Results.*

As for the CK levels, BCAA and PLCB groups were relatively similar at 4 and 24 hours, but BCAA experienced lower levels at 48 and 72 hours. This indicates that the BCAA group experienced soreness and inflammation at the same rate as the PLCB group but was able to quickly recover and reduce inflammation and repair muscle damage. [10]. In conclusion, this study indicates that BCAA supplementation reduces muscle soreness and inflammation 24 hours after injury much faster and more effectively than a placebo. Therefore, it is a fact that BCAA is able to reduce muscle soreness and fatigue, which in turn can reduce injury rates.

In order to find the link between soreness and fatigue, we studied a experiment done by the Orthopedic Research Department at Duke University. This study investigated the role of fatigue in causing muscle strain injuries. The study used muscles of rabbits and focused on their extensor digitorum longus, EDL, muscle. This consists of predominantly fast twitch fibers, which are characteristics found in muscles that are commonly strained by human athletes. For half of the rabbits, this muscle was stretched through a machine which detected the threshold of muscle strain and stretched the EDL muscle at that exact point. For the other half, the muscle was first fatigued by working it through peak isometric tetanic force in cycles of 5 seconds and 1 second rest, which simulated an exercise. The fatigued group was split into either 25% fatigue or 50% fatigue. These muscles were then stretched till failure and data was collected on the force to muscle-tendon unit failure, the percentage of change in muscle length to failure as well as the energy absorbed before failure. A higher value for all of these parameters would mean that the muscle is less susceptible to injury.

Stretch Group	Peak Tensile Force (N)			Muscle Length Increase *(Percentage Change)*			Energy Absorbed (N-cm)		
	1 cm/sec	10 cm/sec	50 cm/sec	1 cm/sec	10 cm/sec	50 cm/sec	1 cm/sec	10 cm/sec	50 cm/sec
Control (N=8)	93.5 +/- 4.1	112.0 +/-7.3	120.4 +/-9.8	17.4 +/- 2.0	16.3 +/- 1.9	17.3 +/- 1.3	108.4 +/- 16.9	122.5 +/- 14.7	133.8 +/- 14.9
Fatigue = 25% (N=8)	90.4 +/- 4.4	109.1 +/- 9.6	117.0 +/-5.9	17.3 +/- 2.4	16.5 +/- 1.8	17.5 +/- 1.5	95.6 +/- 17.8	111.1 +/ 15.7	122.6 +/- 9.0
Control (N=8)	92.0 +/- 8.6	112.6 +/- 12.3	119.8 +/- 10.2	17.8 +/-2.3	17.0 +/- 1.6	17.1 +/- 1.4	109.7 +/- 15.7	131.9 +/- 20.5	133.0 +/- 14.2
Fatigue = 50% (N=8)	85.5 +/- 8.3	106.8 +/- 11.5	114.9 +/- 11.4	17.0 +/-2.3	17.3 +/- 1.9	16.9 +/- 2.4	76.5 +/- 12.6	101.1 +/- 14.7	105.8 +/- 10.6

Figure 5. *Biomechanical raw data: Values to point to muscle rupture.*

As seen in the table, the fatigued muscles received relatively similar scores to the control group for peak tensile force and muscle length increase. However, fatigued muscles, especially 50% fatigue, absorbed significantly less energy than the control. The data from the study suggests that muscle fatigue significantly diminishes the muscle's ability to absorb energy which is related to a reduction in muscle contractile strength. Muscles that are weaker are more susceptible to strains and surrounding ligament injuries as they have less energy to support surrounding structure and execute contractions and extensions. As seen in the stress strain graph, a weaker muscle can be injured by less strain than a fully healthy muscle.

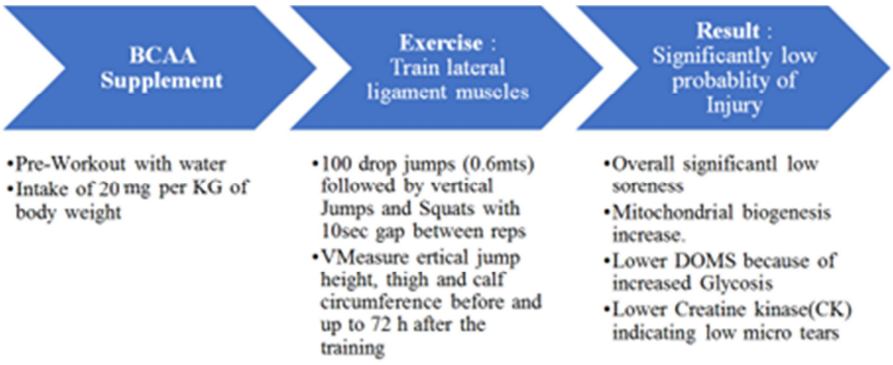

Figure 6. *BCAA supplements lowering Injury probability.*

4. Conclusion

In conclusion, I found that BCAA does help prevent injury, as it can heavily reduce muscle soreness and fatigue, which in effect reduces chances of injury. Ankle injuries commonly occur due to the surrounding muscles being weak, which leads to tears in ligaments and tendons, and the fatigue in muscles is due to reduced glycogen in muscles which reduces the amount of energy the muscle can generate. BCAA combats this by facilitating glycolysis and inducing protein synthesis to help repair sore muscles quicker and help them generate energy again. This research is important to basketball players, and athletes in general, as it is proven that BCAA not only helps build muscle, but also prevents injuries and overall soreness in your body. BCAA supplementation can greatly improve performance and longevity in sports.

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