The effect of BCAA supplementation in aiding muscle soreness to prevent lateral ligament ankle injuries in athletes

Rakshith Srinivasan

Abstract:

Ankle injuries are very common in athletes and comprise of 40% of all sports injuries.[1] These injuries are due to overworking muscles which causes 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. A common supplement used by athletes to combat this is Branched Chain Amino Acid (BCAA), which increases muscle strength and recovery. BCAA's as a whole facilitate glucose uptake to provide energy to muscles during exercise, and leucine in BCAA induces the process of muscle protein synthesis and mitochondrial biogenesis, which increases metabolic enzymes for glycolysis.[2] While it is proven that BCAAs promote muscle growth, it has not yet been proven that BCAA can prevent injuries by healing muscle soreness. This paper reviews existing literature regarding the effect of BCAA in aiding muscle soreness, and how it may prevent ankle injuries in athletes. Results show that BCAAs can decrease chance of injury due to increased muscle recovery by facilitating glycolysis which increases energy production to the sore or weaker muscle.

Introduction:

Ankle injuries are very common in in sports, accounting for around 40% of injuries in athletes.[3] Additionally, these injuries are also one of the most severe and difficult to recover from. 40-50% of athletes who have an ankle sprain experience reinjury and persistent symptoms. A sprain is when a ligament in the ankle tears. In specific, lateral ligament ankle sprains comprise 80.2% of all ankle injuries, and these usually occur due to contact with another player.[4] Sprains can be categorized as a mild, small tear (Grade 1); being moderate where the ligament is torn, but not completely (Grade 2); and where the ligament is torn completely (Grade 3). Symptoms of an ankle injury include pain when putting weight on the ankle, swelling, bruising, and difficulty or incapability of walking.

Soreness causes micro tears in muscle fibers which weakens those muscles, and this can cause injury due to the fact muscles act as support for the ligaments and tendons, and a weaker muscle will cause the ligaments to have to work harder which will increase the chance of tears. When micro tears in muscles occur, it triggers 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). DOMS occurs around 24 hours after exercise and causes reduced range of motion and weaker muscles which are more susceptible to injury.[5] A common supplement used to decrease muscle soreness is Branched Chain Amino Acids (BCAA), which

alleviates muscle soreness and build muscle. BCAA differs from other supplements as it focuses on muscle recovery rather than muscle growth.

While BCAAs are known to reduce soreness and build muscle, as of right now, current literature has not identified a direct connection between BCAA supplementation and reducing injury. Identifying a link between BCAA consumption and injury prevention may benefit athletes by reducing risk of injury. 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. This research was conducted via Literature review from databases such as PubMed, Google Scholar, and ScienceDirect.

Background**:**

The perceived soreness in muscles is a result of microtears on muscle fibers. The tears trigger inflammatory responses. As this happens, the immune system 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.[6] 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.

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. Sports can either be high intensity, like football or basketball. These sports require 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.[7] On the other hand, endurance sports, like soccer and cross country, use 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 reduced endurance.[2,8] 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.

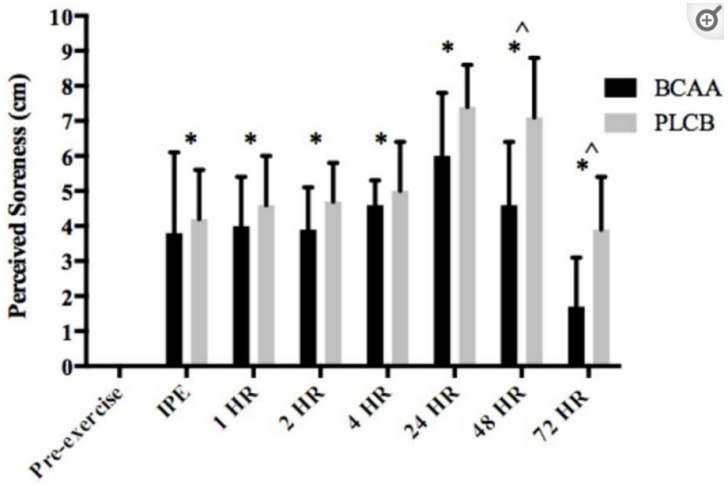
A common workout supplement taken by athletes is Branched-Chain Amino Acids, or BCAA. BCAAs stimulate the building of a protein in a muscle and reduce muscle breakdown. They allow for more intense workouts with faster recovery times. They can be used post or pre workout; supplementing BCAA after a workout will aid muscle recovery while using it before will aid muscle strength and provide energy boosts.[9] 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. BCAAs facilitate glucose uptake and enhance glycolysis. Glycolysis is the process which

converts glucose into ATP, or energy. Glucose provides energy to your muscles during exercise and the leucine in BCAA induces the process of muscle protein synthesis. [2,10] 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. BCAAs are absorbed quicker into the bloodstream and delivered faster to your muscles. DOMS and muscle soreness in general causes muscles to be weaker and more fatigued. However, BCAA supplementation combats this by increasing glycolysis in order to repair microtears in muscles faster.

Results:

A study measured the effects of BCAA on muscle soreness in athletes.[11] This study involved 20 participants, with half using BCAA and half using a Placebo. Participants had similar physical traits and age, as well as protein intake and calorie intake to minimize outside factors affecting the data. To measure soreness in muscles, the study used a blood drawn to measure Creatine kinase (CK) levels in the body, which detects inflammation in muscles or muscle damage. 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.

Figure #1: Effect of BCAA Supplementation on Recovery Study Perceived Soreness Results



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 Figure #1, we can see a graph which models perceived soreness over an amount of time. Both the BCAA and PLCB group were asked to describe their muscle soreness levels at 1 hour, 2 hours, 4 hours, 24 hours, 48 hours, and finally 72 hours. The data shows that there was relatively similar perceived soreness in the first 4 hours, but 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 is attributed to quicker repairing of muscle fiber tears due to the effects of BCAA.

Figure #2: Effect of BCAA Supplementation on Recovery Study CK Levels Results

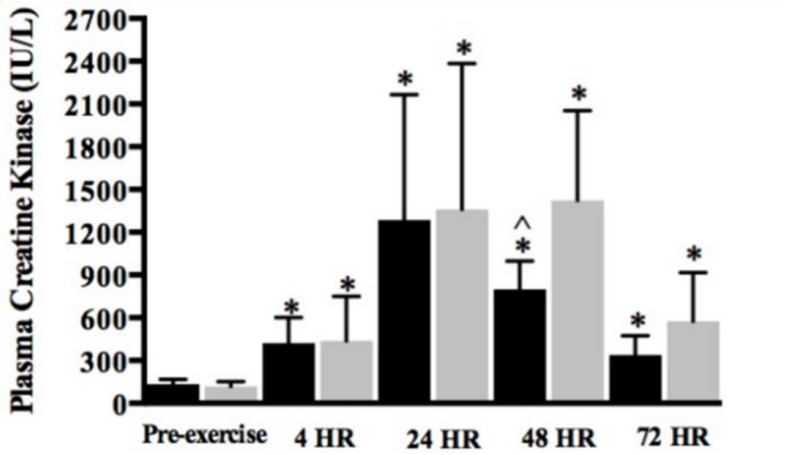


Figure #2 graphs Creatine Kinase levels over time, for both the BCAA group and PLCB group. BCAA and PLCB groups were relatively similar at 4 and 24 hours, but BCAA experienced lower levels at 48 and 72 hours. This indicates that the BCAA group experienced soreness and inflammation at the same rate as the PLCB group but was able to quickly recover and reduce inflammation and repair muscle damage. Overall, this study found that BCAA supplementation reduces muscle soreness and inflammation 24 hours after injury much faster and more effectively than a placebo. Therefore, this study suggests that BCAA is able to reduce muscle soreness and fatigue.

As muscle fatigue and soreness can be combated by BCAA supplementation, the next step is to identify the relationship between fatigue and injury rates. An experiment was conducted by the Orthopedic Research Department at Duke University[12] in which they investigated the role of fatigue in causing muscle strain injuries. They 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, and ~~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.

Figure #3: Biomechanical Raw Data: Values to Point to Muscle Rupture

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

The table in Figure #3 shows both the peak tensile force, muscle length increase, and energy absorbed by 2 controls and 2 fatigued muscles. Data was then collected in intervals of the muscle being stretched at a rate of 1, 10, and 50 centimeters per second. As seen in Figure #3, 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.

Discussion:

The studies reviewed show that BCAA supplementation is directly linked with limiting muscle soreness and muscle soreness has a significant link to muscle strains and ligament injuries. The first study used CK blood markers to measure inflammation rates and soreness in participants. 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. Perceived muscle soreness is due to inflammation and slight tearing in muscle fibers which can be measured through CK tests. BCAA decreased the perception of soreness by ~30% and decreased actual soreness by almost 40% in instances. BCAA does this by facilitating glycolysis in muscles to provide more energy to weakened muscles and enhancing glutamine production to decrease inflammation due to the increased availability of amino acids. The second study found that fatigued muscles increase the chance of muscle strain injuries which increases risk of damage to surrounding ligaments and tendons. Muscle soreness causes muscle fatigue through sustained exhausting muscle contractions, as the limit of endurance is approached. Muscle fatigue most commonly due to lack of ATP and energy supply, which is needed during exercise, since it limits energy production processes such as glycolysis. The second study suggests that fatigued muscles absorb significantly less energy than non-fatigued muscles. Therefore, a fatigued muscle is more susceptible to injury due to a lack of energy in that muscle which causes the surrounding ligaments and tendons to be weaker and more at risk. These two studies suggest that BCAA supplementation is indirectly linked to reducing injury rates since BCAA alleviates muscle soreness which then reduces risk of muscle strain and injury on surrounding ligaments.

Conclusion:

In conclusion, it is found that BCAA is able to 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 athletes, 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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