INTRODUCTION

Bodybuilders, fitness enthusiasts, and even scientific researchers are constantly trying to discover new ways to improve fat loss and overall health. A very popular supplement believed to aid in this process is carnitine. Carnitine is a nutrient found in meat, dairy, and eggs, and is intimately involved in fat metabolism. In theory, if one can transport more fat into the mitochondria, then more fat can be broken down, thereby decreasing body fat. While this may seem logical on the surface, the truth is that there is more to the story than is commonly stated when hearing about carnitine to improve fat loss. This article will review the literature to see if carnitine truly has a role in fat loss, or if it is ineffective as a fat-loss supplement.

A BRIEF OVERVIEW OF CARNITINE

Carnitine is a vitamin-like, water-soluble amine obtained through dietary intake or by synthesis in both the liver and kidneys. Almost all (about 95 – 98%) of the bodily stores of carnitine are in skeletal muscle and the heart, with the remaining 2 - 5% in the liver, kidneys, and blood (11). Carnitine plays a pivotal role in fat metabolism by transporting fatty acids within the mitochondria to be oxidized and generate ATP (11). Without carnitine, this process could not take place and fat oxidation in skeletal muscle would be greatly hindered (6).

The theory behind carnitine supplementation is that more intramuscular carnitine equates to greater fatty acid transport and oxidation, leading to improvements in fat loss. This theory, however, operates under some assumptions: that carnitine translocation is the rate-limiting step in fatty acid oxidation, meaning that increasing free carnitine levels will equate to greater transport of fatty acids into the mitochondria and more fat oxidation; and, that you can increase muscle levels of carnitine through dietary means. If all these assumptions are true, there may be a reasonable case for carnitine supplementation.

INTRAMUSCULAR CARNITINE AND FATTY ACID TRANSPORT AND OXIDATION

Further, when fat availability in the blood is artificially increased during exercise (at 80% VO2max), with no concomitant increases in skeletal muscle carnitine, the muscle still oxidizes more fat (4). This evidence suggests that carnitine translocation may not be the rate-limiting step during fat oxidation. Therefore, increasing muscle carnitine levels may not amount to further increases in fat oxidation. This is because maximal rates may already be achieved with lower levels of muscle carnitine and that artificially high levels of fatty acids in the blood are easily handled without additional carnitine. Nevertheless, is there still a role for increasing muscle levels of carnitine, and if so, is it even possible?

CARNITINE INGESTION

Many studies show that chronic ingestion of carnitine does very little to augment intramuscular stores. In 1994, Barnett and colleagues showed that two weeks of carnitine supplementation at 4 g per day did not significantly affect muscle levels of carnitine (1). Similarly, Vukovich et al. investigated the effects of carnitine supplementation on muscle carnitine concentrations and glycogen content during submaximal exercise, in which subjects ingested 6 g per day of carnitine and still did not show any increases in muscle levels of carnitine (11). Without carnitine, this process could not take place and fat oxidation in skeletal muscle would be greatly hindered (6).

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CARNITINE—EFFECTIVE FAT-LOSS SUPPLEMENT?

Dylan Klein, PhD(C)

Insulin, Carbohydrates, and Choline

While intake of carnitine alone has proved unsuccessful at increasing intramuscular levels, combining carnitine with other substances has been shown to increase the level of skeletal muscle carnitine.
It has been shown by Stephens and colleagues that oral ingestion of carnitine alongside a rather large dose of carbohydrate (CHO) (~80 – 94 g) is able to effectively stimulate the uptake of carnitine (as measured indirectly via blood levels and urinary excretion) (8,14). While 80 – 94 g of carbohydrate may not seem unusual for a bodybuilder or weightlifter to consume in one sitting, the off-season, or even in the earlier stages of dieting, the dosage may come into conflict during the later stages of prep (when carbs are being reduced), or for those who have lower CHO requirements. Moreover, even replacing some of the carbohydrate with whey protein (40 g CHO + 40 g whey) has shown to actually have an antagonistic effect on muscle carnitine uptake despite resulting in similar blood levels of insulin and in the face of enhanced carnitine absorption in the gut compared to carbohydrate alone (5). Therefore, some practical limitations may come into play, especially when it means eating relatively high amounts of carbohydrate to gain what may be a trivial fat-burning effect from carnitine.

Indeed, when subjects were given oral carnitine (2.7 g per day) alongside large doses of carbohydrate (80 g CHO twice daily), their carnitine stores increased by 21% and their bodyweight remained relatively unchanged (9). In contrast, those who were not given the carnitine supplement had no change in carnitine stores and actually increased their bodyweight and increased their fat mass by 4.5 lb (9).

Another effective way to increase muscle carnitine stores is in combination with choline. The combination of carnitine and choline has not only shown to increase muscle levels of carnitine, but has also been shown to reduce body fat compared to placebo (1 – 1.5% reduction in body fat) (3). These results, however, should be interpreted with caution as the measurements done to ascertain body fat levels were skin calipers and bioelectrical impedance analysis, two methods that are highly inaccurate and prone to error by the measurer. Thus, even when carnitine stores are increased, the effect on reducing body fat is likely negligible. Moreover, none of these studies incorporated long-term resistance training programs with controls on dietary intakes during a well-planned weight-loss diet.

CONCLUSIONS

Although it may be possible to increase skeletal muscle levels of carnitine by combining it with relatively large amounts of carbohydrate repeatedly throughout the day, or by taking it with choline, there is limited data that shows that carnitine is a potent fat-burner that will result in significant reductions in fat mass. Furthermore, the practical limitations of consuming carbohydrate that equates to 640 kcals each day make the usefulness of carnitine as a fat-burner questionable, especially compared to well-known effects of a sufficient caloric deficit combined with increased physical activity. Thus, currently, carnitine seems to have a limited role when trying to reduce body fat. More research is needed in randomized, placebo-controlled trials alongside rigorously controlled diets and well-structured exercise programs to determine whether carnitine could be an effective additive to a weight-loss program.

REFERENCES


CARNITINE—EFFECTIVE FAT-LOSS SUPPLEMENT?


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Dylan Klein earned his Bachelor of Science degree in Nutritional Sciences, Dietetics from Rutgers University, where he is currently pursuing a Doctorate in Nutritional Biochemistry and Physiology. His research currently focuses on the molecular adaptations of skeletal muscle to exercise. In addition, Klein was also the Head Nutritionist for the Rutgers University football team for the 2012 – 2013 season and the Assistant Nutritionist for the 2011 – 2012 season. In addition, Klein was the Head Nutritionist for the Rutgers’ Army Reserve Officers’ Training Corps (ROTC) program from 2011 – 2013. Outside of his role as a nutritionist on campus, Klein also works with the lay public, both in person and via email/phone correspondence where he specializes in fat loss, muscle gain, and body recomposition. He also provides more information on a blog called “Calories in Context.”

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