The efficacy of L-carnitine as an ergogenic aid

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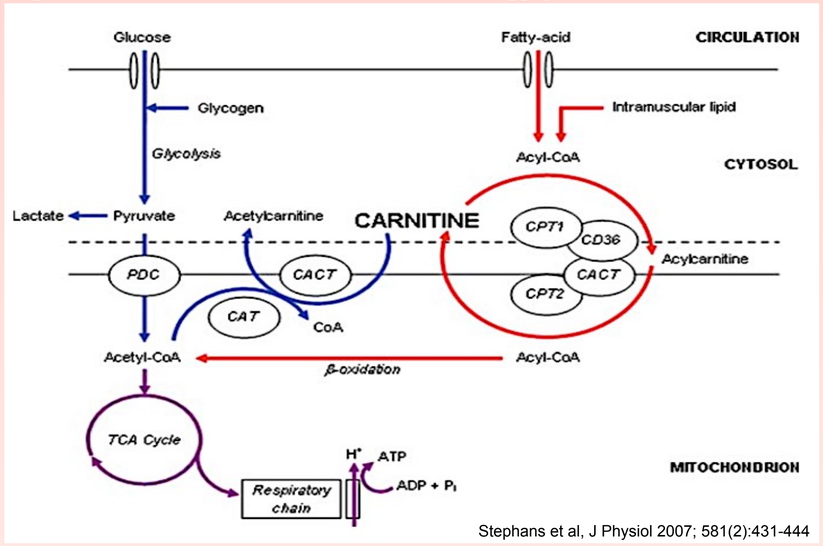
ABSTRACT

Carnitine is an endogenous compound essential for energy production, playing dual roles as a component of fatty acid translocation through the mitochondrial membrane and as a buffer for accumulating acetyl-CoA. In addition, it has been shown to have various effects on the brain, altering the perception of exercise intensity. Chronic training may lower levels below baseline, thus supplementation is recommended to stabilize intracellular carnitine levels. Chronic ingestion of 30-56 mg/kg/d of L-carnitine taken with carbohydrates can effectively increase muscle total carnitine concentration, enabling its ergogenic effects. Although findings have been inconsistent, L-carnitine supplementation improves exercise performance by increasing fatty acid oxidation, sparing glycogen, reducing lactate accumulation, increasing efficiency of glycogen utilization, decreasing rate of perceived exertion, and allowing a higher work output. More studies are necessary to determine the optimal dose of L-carnitine, the optimal dose of carbohydrates for intramuscular uptake, and the effect of L-carnitine on prolonged endurance and resistance training.

MECHANISMS:

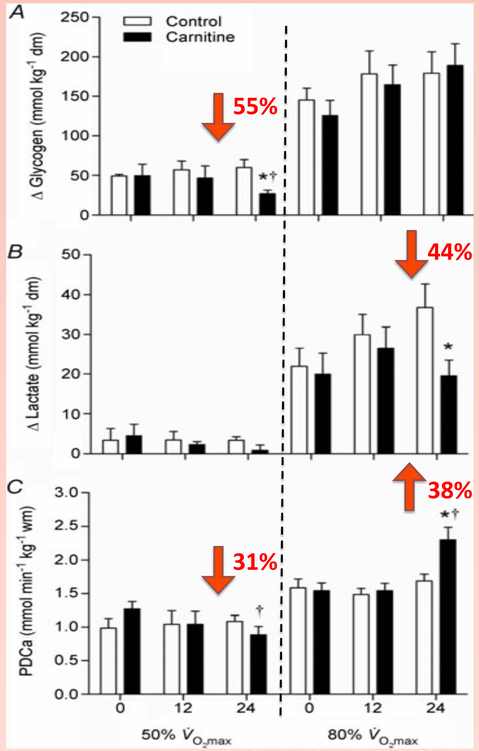
Figure 1. Dual role of carnitine in energy production.



Stephans et al, J Physiol 2007; 581(2):431-444

EFFECT ON EXERCISE PERFORMANCE

Figure 2. 24 wk L-carnitine supplementation vs. control



Wall et al, J Physiol 2011; 589 (4): 963–973

Exercise at 50% VO_{2max} (moderate intensity):

- Spares glycogen
- Lowers PDC activity

Overall effect:

- Less glucose used as energy source
- More fat breakdown

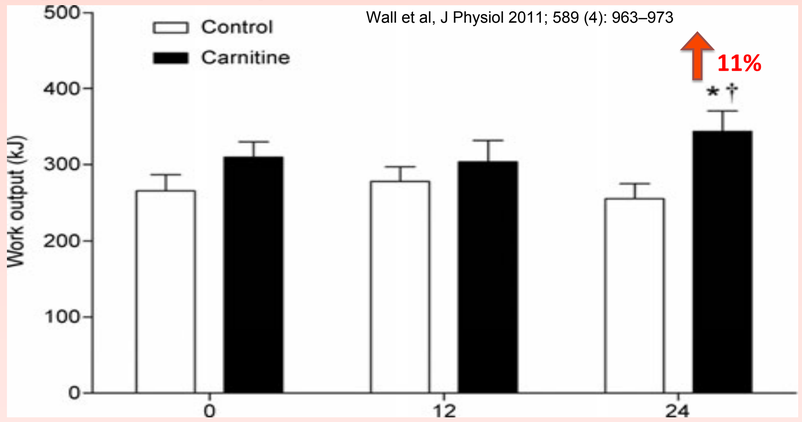
Exercise at 80% $V0_{2max}$ (high intensity):

- Increases PDC activity
- Lowers lactate accumulation
- Attenuates the decrease in cellular energy status

Overall effect:

- Better extraction of energy from glucose
- Delay in fatigue

Figure 3. "All out" performance test.



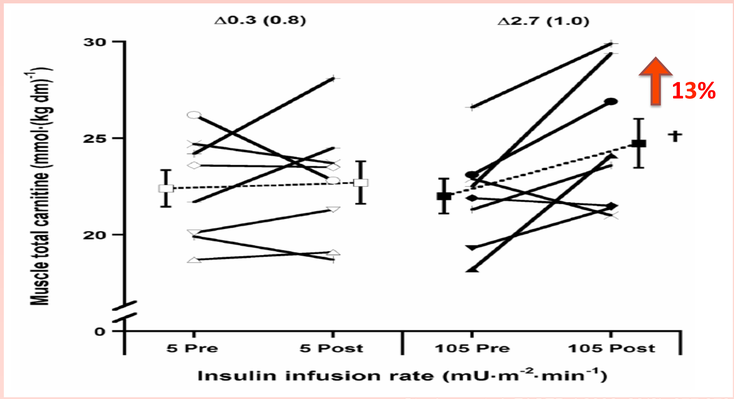
Wall et al, J Physiol 2011; 589 (4): 963–973

SUBJECTIVE PERCEPTION OF EXERCISE

Rating of perceived exertion lower by 11% vs. control (14.0 vs 16.2 on Borg scale) following supplementation. Improved glycolytic efficiency only partially accounts for this decrease, considering carnitine has known effects on the brain. Acetylcarnitine affects neuroplasticity, membrane modulation, and neurotransmitter regulation.

ROLE OF CARBOHYDRATES

Figure 4. Insulin stimulates the accumulation of intramuscular carnitine.



Stephens et al, FASEB J 2006; 20(2): 377-379

FUTURE RESEARCH:

Optimal frequency, duration and dose of supplementation and its effect on endurance and resistance performance.

CONCLUSION:

L-carnitine improves exercise performance (increased work output) by playing roles in fatty acid translocation and buffering of glucose breakdown by-product, and through its effect on the brain. During exercise at low intensities, there is an increase in the breakdown of fat for energy production while sparing glycogen; whereas during high intensity exercise glucose is used more efficiently. To increase muscle carnitine, 30-56 mg/kg/d taken in single or multiple doses must be consumed with carbohydrates. Carnitine supplementation causes no side effects.